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COMMENTS ON SOME NEW AND ALREADY KNOWN CIRRIPEDS WITH EMENDED TAXA, WITH SPECIAL REFERENCE TO THE PARIETAL STRUCTURE*

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With Plate VI and 20 Text-figures

Introduction

The main aim of this paper is to describe a new species of the genus *Acasta* recently discovered and to revise some of the *Balanus amphitrite* complex hitherto known from Japan and the neighboring waters from modern taxonomical and anatomical aspects.

For these purposes, I have re-examined and dissected available materials of some important or problematic forms or subspecies of the "*Balanus amphitrite*" series contained in the extensive zoological collections of the Seto Marine Biological Laboratory and illustrated them in detail, when necessary, particularly in taking account of the parietal structure of the shell.

Our knowledge on the so-called "lame hypodermique" or "interlaminate figure" and "intralaminate figure" recently proposed to call for species identification of sessile Balanomorph barnacles has appreciably advanced by many contributions made particularly by some recent workers such as DAVADIE (1952, 1963), CORNWALL (1956–1959), HARDING (1962), WEISBORD (1965), NEWMAN, ZULLO and WAINRIGHT (1967) and Ross and NEWMAN (1967) since the time of DARWIN's classics.

In early time of my cirripedological research I had already enumerated seven forms or subspecies of *Balanus amphitrite* DARWIN as occurring in the Japanese waters following the current manner of systematics adopted by earlier authors since DARWIN (cf. HIRO, 1938). Since I have published a short paper on the widespread *B. a. hawaiiensis* BROCH (UTINOMI, 1960), this revisionary work, although not all I intend, has long been in mind, but its actual publication has been retarded till now, although further stimulated by Dr. HARDING's re-study of the DARWIN's types of varieties of *B. amphitrite* (1962) on the way of progress.

Now I am of opinion that Darwinian varieties are a conglomerate of several species and subspecies belonging to the subgenus *Balanus* s. str., some most closely

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related ones being to be recognized as subspecies, if considering the complicated structure of the compartments which involves the complex of the so-called "intra- and interlaminate figures". However, the interlaminate figure, discussed by DAVADIE and CORNWALL is practically less important and rather technically exacting to examine for the systematic purpose solely. Therefore, I treat here solely the basal edge of the compartments after the calcareous basis was carefully detached off, without sectioning the wall shell itself, in order to detect the relationship between the allied forms in the *B. amphitrite* complex and the other group concerned here.

This paper deals with the following ten species and subspecies of which the taxa are newly emended:

1. *Balanus amphitrite amphitrite* DARWIN sensu HARDING (=*B. a. hawaiiensis* BROCH, 1922)
2. *Balanus uliginosus*, nom. nov. (=*B. a. krügeri* NILSSON-CANTELL, 1932)
3. *Balanus pallidus* DARWIN (=*B. a. pallidus* and *B. a. stutsburi* DARWIN, 1854)
4. *Balanus albicostatus albicostatus* PILSBRY (=*B. a. albicostatus* PILSBRY, 1916)
5. *Balanus albicostatus formosanus* HIRO (=*B. a.* forma *formosanus* HIRO, 1938)
6. *Balanus variegatus cirratus* DARWIN (=*B. a. cirratus* DARWIN, 1854)
7. *Balanus reticulatus* nom. nov. (=*B. a. communis* DARWIN, partim; *B. a. tesselatus* UTINOMI, 1964)
8. *Acasta spinifera* spec. nov.
9. *Creusia indica* (ANNANDALE) (=*C. spinulosa* var. 11 DARWIN, 1854; *C. s.* forma *angustiradiata* BROCH, 1931; *Pyrgoma indicum* ANNANDALE, 1924)
10. *Megatrema oulastreae* (UTINOMI) (=*Pyrgoma oulastreae* UTINOMI, 1962)

Revised Descriptions and Discussions

1. *Balanus amphitrite amphitrite* DARWIN sensu HARDING
(Japanese name: Tatezima-huzitubo)

(Plate VI, fig. 1)

B. a. var. (1) *communis* DARWIN, 1854, p. 240 (partim).

B. amphitrite: PILSBRY, 1907, p. 190; PILSBRY, 1927, p. 312—Oahu, Hawaii.

B. a. communis: NILSSON-CANTELL, 1921, p. 311, fig. 64—Messina, Mediterr. and Sunda Is.; NILSSON-CANTELL, 1931, p. 122, fig. 3—many localities of Europe and Cape of Good Hope; NILSSON-CANTELL, 1938b, p. 36, fig. 7—Madras and other localities along the Ind. Ocean.

B. a. forma *hawaiiensis* BROCH, 1922, p. 314, fig. 56—Pearl Harbour, Honolulu and Kaladis Point, Mindanao.

B. a. var. *denticulata* BROCH, 1927, p. 133, fig. 14—Suez Canal; STUBBINGS, 1961c, p. 23, fig. 4—from ship-hulls.

B. a. hawaiiensis: HIRO, 1937, p. 432, figs. 20–21—Seto; Hiro, 1938, p. 304, fig. 4—Misaki, Seto, Kure, Sasebo and Maizuru (all of Japan); NILSSON-CANTELL, 1938b, p. 40, fig. 9—Persian Gulf; HIRO, 1939, p. 260—Taiwan; UTINOMI, 1949, p. 22—Sasebo; UTINOMI, 1956, p. 52, pl. 26, fig. 8 (colored); UTINOMI, 1960, p. 43 (synonymy); STUBBINGS, 1961a, p. 173—Persian Gulf; ROSS, 1962, p. 12, figs. 1–5—western Mexico.

B. amphitrite: SOUTHWARD and CRISP, 1963, p. 27, fig. 11 (colored); STUBBINGS, 1963, p. 15—Las Palmas, Gran Canaria.

B. a. amphitrite: HARDING, 1962, p. 274, pls. 1–2 (revision); STUBBINGS, 1964b, p. 337—Angola; STUBBINGS, 1965, p. 886—Senegal; NEWMAN et al., 1967, pp. 168, 170.

Description: For details see HIRO, (1937, p. 432 and 1938, p. 304) and UTINOMI (1960, p. 43) for *Balanus amphitrite hawaiiensis* and HARDING (1962, p. 274) for *Balanus amphitrite amphitrite*, as cited above.

Remarks: As mentioned by NEWMAN et al. (1967, p. 170, footnote) very recently, there has been considerable confusion upon this taxon. This is mainly due to DARWIN's inadequate description and inadvertent muddling up of separate varieties, samples and opercular valves (internal bodies too) from different sources. So presumably earlier authors including myself too might have been much perplexed in identification and nomenclature. Indeed, eminent cirripedologists Drs. BROCH and NILSSON-CANTELL have often confused *communis* and *hawaiiensis* (or *denticulata*) and on other occasions treated as different subspecies or forms. These earlier procedure has misled most of later workers on the taxonomy of cirripeds. Dr. HARDING of the British Museum (Nat. Hist.) has attempted to re-examine the original specimens of various varieties of *Balanus amphitrite* which DARWIN himself studied and dissected, and then he has designated lectotypes and proposed a revised nomenclature according to the modern usage of nomenclature.

He has designated a complete specimen chosen from about forty specimens on a piece of bamboo from Natal, South Africa on which the name *Balanus amphitrite* is clearly written by DARWIN's hand as referable to var. (1) *communis* of DARWIN. The photographs of *B. a. amphitrite*, thus renamed by him (HARDING, 1962, pl. 1—outer shells, opercular valves and cross section of a paries; pl. 2—mouthparts and cirri) clearly agree with *B. a. hawaiiensis* BROCH, the types of which I could re-examine through the courtesies of Dr. Torben WOLFF of the Zoological Museum, Copenhagen, Denmark. Curiously enough, the tergum (HARDING's pl. 1, figs. *e* and *f*) does not correspond to DARWIN's pl. 5, fig. 2*l* for var. *communis*. HARDING, however, gave no mention on this point. The original diagnosis of var. *communis* given by DARWIN, *i. e.* "only one or two of them have a narrow spur" is too brief and vague diagnostically to understand.

On the other hand, the tergum of var. *pallidus* figured by DARWIN (1954, pl. 5, fig. 2*k*) seems to be similar to that of var. *communis* (i. e. *B. amphitrite amphitrite* now called) which HARDING photographed (his pl. 1, fig. f)[1], as well as that of *B. a. hawaiiensis* BROCH.

Probably the materials on which DARWIN himself based to illustrate had been lost in the time of writing.

1) On this point, HARDING (1962, p. 280) only mentions as follows: "I do not believe the tergum figured by DARWIN is of this species (i. e. *B. pallidus pallidus* DARWIN)."

As mentioned above, the original diagnosis of var. (1) *communis* DARWIN does not exactly agree with HARDING's description and illustrations. However, to avoid further confusion in nomenclature I here follow the revised nomenclature proposed by HARDING, as he is the first revisor of the DARWIN's types. Further I will discuss on this problem in the section of *Balanus reticulatus* (nom. nov.).

2. *Balanus uliginosus* UTINOMI, nom. nov.
(Japanese name : Doro-huzitubo)

(Text-figs. 1–2; Plate VI, figs. 4–6)

B. amphitrite var. *niveus*: KRÜGER, 1911, p. 51, pl. IV, fig. 35 (opercular valves only)—Making, Pescadores. (not DARWIN)

B. a. krügeri NILSSON-CANTELL, 1932, p. 24, textfig. 10, pl. I,—Japan (exact locality not mentioned, but presumably Tokyo Bay).

B. a. krügeri: HIRO, 1938, p. 305, fig. 5 (opercular valves only—Omori, Tokyo Bay; Iki Is.; southwest Korea; HIRO, 1939, p. 263—from ship-hulls in Takou, came from Kwanchow, South China; UTINOMI, 1949, p. 22 (listed only)—Ariake Sound oyster farms and Tomioka, Amakusa Is.; UTINOMI, 1956, p. 52, pl. 26, fig. 9 (colored); TARASOV and ZEVINA, 1957, p. 190, fig. 75 (cited only); UTINOMI, 1962, p. 216 (listed only)—Nomosaki; ZEVINA and TARASOV, 1963, p. 93, fig. 12 (opercular valves)—Tangku, Paiho River-estuary; Yantai, N. of Shantung Penin., North China.

Material Examined: (1) Omori laver-culture bed, Tokyo Bay. Coll. the late Dr. Kintaro OKAMURA. (2) Kunsan, Mokpo and Hanchon (all of the southwest coast of Korea). Coll. the late Dr. Shiro OKUDA. (3) Hama oyster-culture farm, Ariake Sound. Coll. Mr. Saburo INUO. (4) Kasaoka Bay, Seto Inland Sea. Coll. Dr. Shinichiro FUSE. (5) Tatigatani Inlet, Tanabe Bay. Coll. H. UTINOMI, 1934.

Lectotype. One specimen selected from the material from Tatigatani Inlet, Tanabe Bay and deposited in the museum of the Seto Marine Biological Laboratory, registering as SMBL-Type 204, together with 2 paralectotypes.

Size of Types. Lectotype—Carino-rostral diameter 24.5 mm, height 24 mm, orificial diameter 17 mm.

Paralectotypes—Carino-rostral diameter 26.5 mm, height 25 mm, orificial diameter 16 mm; carino-rostral diameter 23 mm, height 14.5 mm, orificial diameter 15 mm.

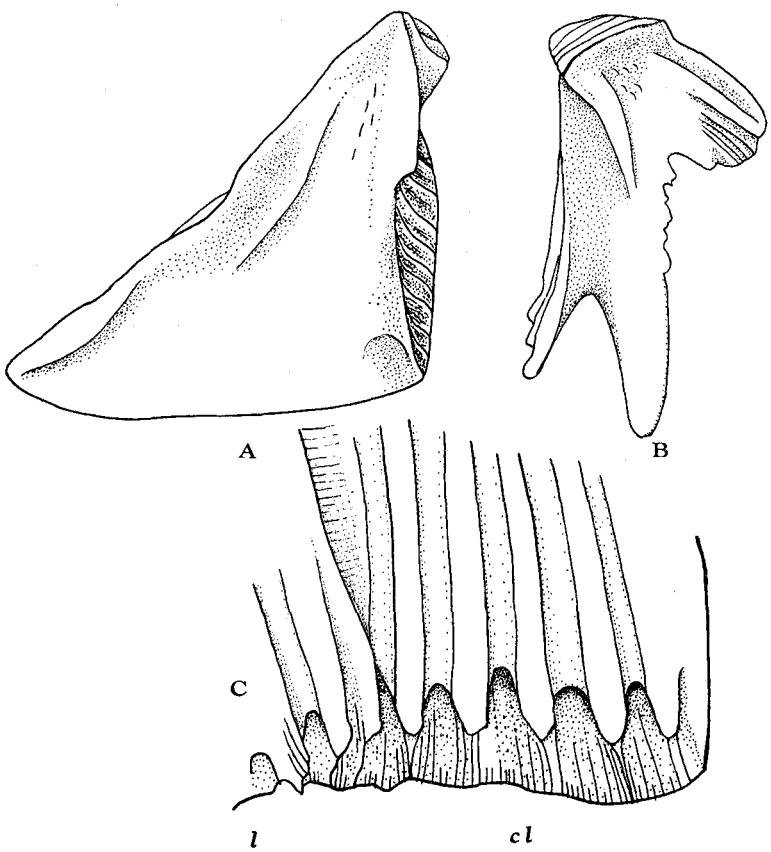
Supplementary Description: The shell is typically tubulo-conical, the rostral side being convex and the carinal side steep or slightly upturned. The orifice is large, rhombic to ovate and moderately toothed around the margin. The basis is flat or concave.

The compartments are externally smooth, polished. The parietes are fawn in ground color, becoming darker purplish upward, and marked with dark purple narrow longitudinal stripes closely set, never crossed by any horizontal bands.

The radii are broad, quite white and with oblique summits. The alae are

also with oblique summits and tinged with dark purple. The sutural edges of the compartments on both sides are transversely septate.

Internally, the sheath is one-half of the height, transversely striated on its upper two-thirds and dark purple colored except along the lateral margins and along the lower non-striated margin which is free from the inner lamina. The face of the inner lamina below the sheath is strongly ribbed equidistantly all throughout. These



Text-fig. 1. *Balanus uliginosus* UTINOMI, nom. nov. from Kasaoka Bay.
A, scutum, inner view. B, tergum, inner view. C, basal part of compartments, inner view. *cl*—carino-lateral compartment; *l*—lateral compartment. All ×12

inner ribs (costae) are, as usual, flat or grooved up and 4-fluted on both sides, and their lower ends strongly project overhanging the thin primary septa which connect the inner and outer laminae of the wall. When well developed, there are numerous riblets or teeth in 2 orders inside the base of the outer lamina; the larger riblets lying within the parietal tubes may be said the incomplete secondary septa and the smaller denticles the tertiary teeth. The former (usually 1–3 per parietal tube) nearly reach

the the crenated basal margin of the inner lamina, while the latter are only restricted to the basal margin of the outer lamina, interlocking the calcareous basis.

The parietal tubes are arranged only in one row between the inner and outer laminae and rectangular in section at base, and horizontally septate in the upper part of the wall.

The scutum is concave externally, either longer than wide or wider than long, dark purple in the middle broad depression, bounded by white elevations on both sides; the growth-lines are widely spaced, not rasied, but between them finely striated transversely. Internally, the upper part is smooth or slightly rugged and the adductor ridge is strong but short and the adductor depression is shallow; the pit for the lateral depressor muscles is obscurely indicated. The articular ridge is strong, about one-half as long as the tergal margin, forming an articular lobe at apex.

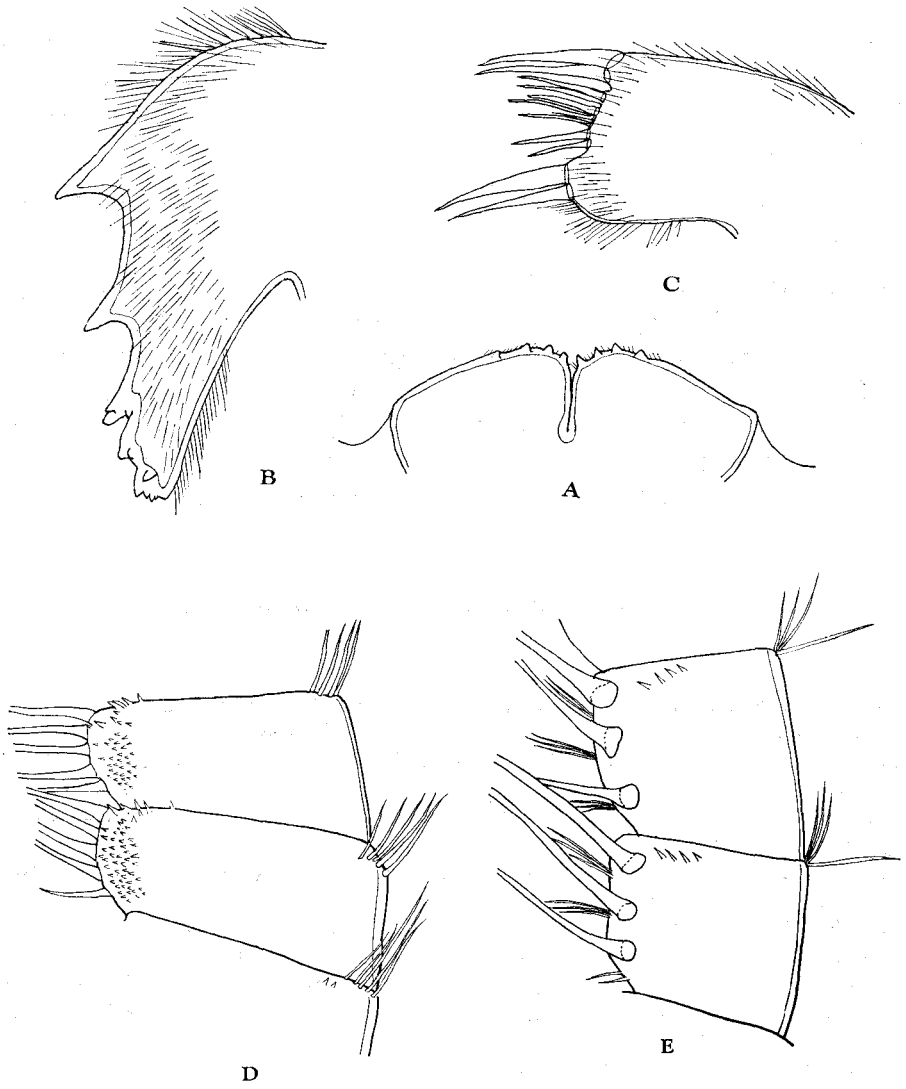
The tergum is 3-prolonged in outline and quite flat externally, but with a shallow furrow where is white as in the carinal side; the scutal side is dark purple colored; the growth-lines are moderately developed. Of the three prolongations the spur is the longest, roundly pointed and the basal margin of the valve is deeply notched on both sides of the spur; the basal margin on its carinal side is usually strongly dentate, with 2–5 teeth. The basi-scutal angle is sharply pointed. The carino-basal prolongation is roundly truncated at end and bears about 5 long crests for the depressor muscles.

The mothparts are also characteristic as follows: The palp is distinctly clavate and bears a distal series of long setae. The labrum has invariably 4 teeth on each side of the deep median notch. The mandible has 5 teeth of which the second and third are bifid and the fifth one is shortly pointed and united with the pectinated inferior angle. The first maxilla has 12 spines of different size along the nearly straight frontal margin below the upper pair of large spines, and the lower part where is prominently protuberant than the upper two-thirds and bears 2 largest spines. The second maxilla is bilobed, rather small, the distal lobe being oval in outline and larger while the lower spherical and strongly setose.

The cirri in a specimen (14 mm in carino-rostral diameter) show the following number of segments:

I	II	III	IV	V	VI
18 11	15 15	12 15	36 37	32 32	31 32

In cirrus I, the posterior ramus is about two-thirds as long as the anterior one. Cirrus II has subequal rami, formed of plump, protuberant segments. Cirrus III has also subequal rami and each segment is short, broad and bears 4–5 pairs of long setae on its protuberant frontal border and many spinules in distal series on both sides. In the posterior longer cirri IV-VI, both rami are subequal and each intermediate segment is quadrangular and armed with 3–4 pairs of long stout setae,



Text-fig. 2. *Balanus uliginosus* UTINOMI, nom. nov. from Omori, Tokyo Bay (A-C) and Kasaoka Bay, Seto Inland Sea (D-E).
A, labrum. B, mandible. C, first maxilla. D, intermediate segments of posterior ramus of cirrus III. E, intermediate segments of cirrus VI. D-E, ×70

accompanying a tuft of much smaller setae between each pair on the moderately curved anterior border and a tuft of smaller setae at the posterodistal angle; in addition a transverse row of spinules occurs near the anterodistal corner on both sides.

Habitat: This barnacle usually occurs in groups on bamboo or tree branches artificially set on muddy beds for oyster culture in less-saline quiet bays or estuaries. So it is essentially intertidal in habitat but rare on intertidal rocks or stones where *Balanus albicostatus* is abundant.

Distribution: Hitherto known only from southern Japan, southern Korea, China and Taiwan.

Remarks: This barnacle was first described by NILSSON-CANTELL (1932) under the name of *B. amphitrite krügeri* (n. ssp.) based on the material collected by HILGENDORF from Japan (possibly Tokyo Bay). According to the international code of nomenclature presently adopted, the name *krügeri* is unfortunately inadmissible as it is preoccupied by *Balanus krügeri* PILSBRY (1916) which is a valid species belonging to the other subgenus *Chirona*. Therefore, I propose here to raise it to the specific rank and to give a substitute name *Balanus uliginosus* as referring to its mud-dwelling habitat.

3. *Balanus pallidus* DARWIN

(Text-fig. 3)

Balanus amphitrite var. (3) *pallidus* DARWIN, 1854, p. 240, pl. V, fig. 2*c* (not fig. 2*k*).
B. a. var. (6) *stutsburi* DARWIN, 1854, p. 240, pl. V, figs. 2*d*, 2*i*, 2*m-o*.
B. dybowskii GRUVEL, 1903, p. 143, pl. I, figs. 1–9; pl. 4, fig. 14; GRUVEL, 1905, p. 257, figs. 270E et 286—Congo.
B. a. venustus: NILSSON-CANTELL, 1925, p. 28, fig. 11 (not DARWIN)—Kamerun (Cameroon), on mangrove roots.
B. a. stutsburi: NILSSON-CANTELL, 1931a, p. 125, fig. 5—Kamerun (Cameroon); NILSSON-CANTELL, 1938a, p. 179—Belgian Congo.
? *B. a. insignis* NILSSON-CANTELL, 1938b, p. 41, fig. 11; pl. I, fig. 1—Sumatra, on wood.
? *B. a.* var. *pallidus*: STUBBINGS, 1961c, p. 27, fig. 6—tropical West Africa.
B. a. var. *stutsburi*: STUBBINGS, 1961c, p. 24, text-fig. 5—Trop. West Africa; STUBBINGS, 1963b, p. 19, fig. 6—Banana Creek, Congo; SANDISON, 1962, p. 517, figs. 3–12—Guinea Coast.
B. pallidus pallidus: HARDING, 1962, p. 278, pl. 3, figs. a-r.
B. pallidus stutsburi: HARDING, 1962, p. 281, pls. 4–5.
B. pallidus: STUBBINGS, 1964b, p. 338, fig. 4—Congo Estuary; STUBBINGS, 1965, p. 887—Portuguese Guinea.

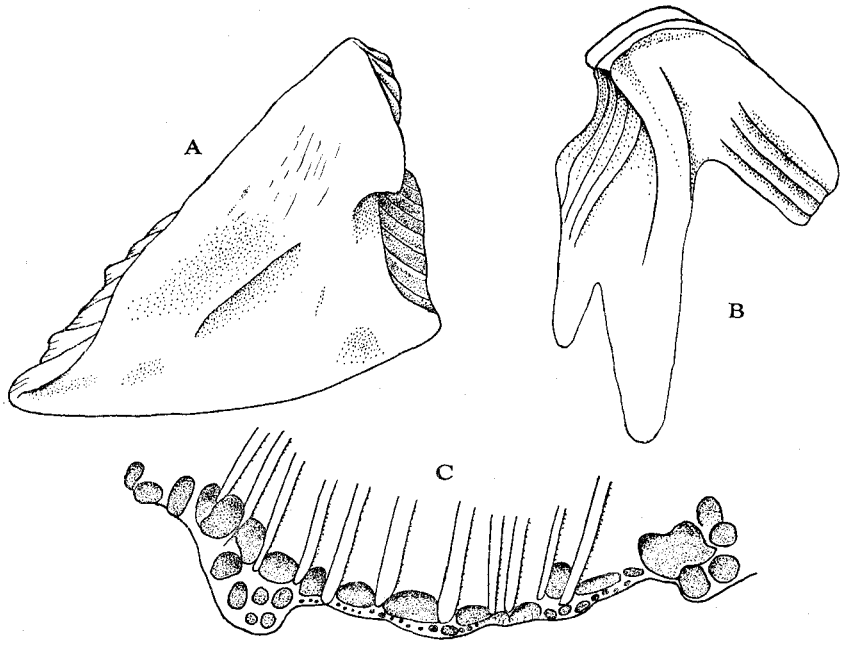
Material Examined: (1) Ikorudu, Lagos, Nigeria. Coll. Miss Eyvor E. SANDISON. 1959. (2) Tromtway, Bombay, on submerged timber. Coll. Mr. A. B. WAGH. 1964.

Supplementary Description: The majority of West African specimens I have examined are, as repeatedly reported, wholly white, and the shell, when ag-

gregated, tubulo-conical and nearly smooth externally, while a simple intact specimen collected at Bombay Coast is conical and dark purple-striped.

The scutum in a dissected specimen from Nigeria is wider than long, and has a short adductor ridge in the middle of the interior and a slight depression for the lateral depressor muscles; the rest is nearly smooth and the articular ridge is well developed, about one-half of the height and rectangularly angled at the lowest end, the articular lobe at the apex does not project so strongly. A broad triangular dark purple patch outside of the scutum is distinct in colored variant from Bombay.

The tergum is 3-prolonged as in the preceding *B. uliginosus*. The longest spur of three prolongations is gradually tapering and lies at about its own width distant



Text-fig. 3. *Balanus pallidus* DARWIN from Lagos, Nigeria.
A, scutum, inner view. B, tergum, inner view. C, basal part of lateral compartment, inner view. All ×12

from the sharply pointed basiscutal angle; its carinal side sloping to the wide notch of the basal margin is straight, lacking any teeth as seen in *B. uliginosus*. The basi-carinal prolongation is truncated at end, about twice as long as wide and bears 2–3 long crests; the number of crests may be apt to vary considerably according to the degree of excavation of the basal margin. In any way, this prolongation is much more than the basi-scutal angle but lesser than the spur. The articular furrow is very broad. The exterior of both valves is quite flat, excepting a distinct spur fasciole.

The parietes are predominantly white, although occasionally colored, as often pointed out by European authors. The nature of epidermis whether persistent or not that was emphasized by DARWIN for all varieties of *B. amphitrite* is of no systematic importance, because this depends largely upon the condition of preservation or the duration of time after collecting.

The face of the inner lamina below the sheath is ribbed. These ribs are relatively low, only developed in the lower half, slightly fluted on both sides, and terminate to rounded projections just above the marginal base of the outer lamina.

The parietal tubes are arranged in two layers, as clearly shown by the photographs of section of the parietal wall (cf. HARDING, 1962, pl. 3, fig. *m* and pl. 4, figs. *g-h*). These parietal tubes are one-layered in the upper part and transversely septate as can be seen from the outside in much eroded material, while at the base the pores are relatively smaller than those of the one-layered porous forms or species of *Balanus*, round to oval in outline and in the thick-walled part of the basal margin they are apt to arrange more irregularly, probably by adding with marginal growth increments. This is also the case with other multiporous species of *Balanus* (e. g. *B. gregarius, B. nubilus* and *B. cariosus*) and *Tetraclita*. Furthermore, the outer lamina is slightly thicker than the inner lamina and normally smaller subsidiary pores are arranged in one row irrespective of occurrence of primary parietal pores stated above. It should also be noted that the basal edge of these primary and subsidiary pores is quite entire, without any teeth.

Concerning the internal animal body, further descriptions or comments would be superfluous, as they have been fully described by SANDISON, STUBBINGS and HARDING in particular.

Habitat: Strictly intertidal, on moles, shells or mangrove roots in less-saline lagoons, estuaries or protected harbors.

Distribution: Hitherto known with certainty from West Africa and west coast of India.

Remarks: Although we recognize DARWIN's inadmissible mistake shown in the disagreement between his diagnosis and illustrations for var. *pallidus*, as very lately noticed by HARDING (1962), the procedure of uniting together DARWIN's two varieties *pallidus* and *stutsburi* under one name, as done by STUBBINGS (1965) for the first time, seems to be systematically reasonable. He (1963b) also regarded GRUVEL's *Balanus dybowskii* as a heavily eroded form of *B. pallidus*. I support both of his disposal. But, I am not in agreement with HENRY (1959), regarding a barnacle intruded into Potomac River on the Atlantic coast of North America as *B. a. pallidus* DARWIN. In fact, brief photographs given by her (pl. I, fig. 4; pl. 3, fig. 7, middle in the lower row and fig. 8) may suggest to be referable to either *B. improvisus* or *B. eburneus*, common there.

The unusual multiporous structure of the wall in this species represents its unique

status within the *B. amphitrite* complex currently treated, apart from the apparent similarity of the opercular valves to those of the preceding *B. uliginosus* known only from the East Asiatic coasts. Although this species may plainly be accepted as belonging to the series of *B. amphitrite*, one of the eight series that PILSBRY (1916) grouped non-critically, such peculiarly perforated wall may suggest a near affinity to the series of *B. perforatus*, especially fossilized *B. laevis* on the other hand (cf. PILSBRY, 1916, pls. 27–28; DAVADIE, 1963, pls. XI-XII).

4. *Balanus albicostatus albicostatus* PILSBRY (emend.)
(Japanese name: Sirosuzi-huzitubo)

(Text-figs. 4–5 and Plate VI, fig. 2)

? *Balanus violaceus* GRUVEL, 1903, p. 133, pl. 1, figs. 11–14; pl. 4, fig. 12; GRUVEL, 1905, p. 227, figs. 254A et 255—unknown locality. (The name *violaceus* is preoccupied by *Lepas violacea* GMELIN, being a *Balanus*, after PILSBRY.)

B. amphitrite communis: KRÜGER, 1911, p. 51, pl. I, fig. 7; pl. IV, fig. 34 (40 is typographical error)—Hongkong; Yokohama.

B. a. albicostatus PILSBRY, 1916, p. 90, text-fig. 18; pl. 20, figs. 1–4—Yedo Bay, Shinagawa (both in Tokyo Bay) and Hirado, Kyusyu.

B. a. albicostatus: NILSSON-CANTELL, 1921, p. 314—Hongkong, Kobe and Yokohama; HIRO, 1938, p. 303, fig. 3 (opercular valves—various localities of Japan, from Asamusi to Isigaki-zima and Korea; UTINOMI, 1949, p. 22 (listed only); TARASOV and ZEVINA, 1957, p. 183, fig. 65 (cited only); UTINOMI, 1956, p. 52, pl. 26, fig. 10 (colored); ZEVINA and TARASOV, 1963, p. 91, fig. 11 (opercular valves and mouthparts)—Lüta, Yantai, Tsingtao, Chusan Is. and Hainan Is. (all of Chinese coasts).

B. albicostatus albicostatus: UTINOMI, 1966, p. 5 (listed only)—Tomioka and Nomosaki.

Types: USNM no. 32950 from Japan, deposited in the U. S. National Museum, Washington, D. C.

Material Examined: Hatakezima Islet in Tanabe Bay. H. UTINOMI Coll. 1942.

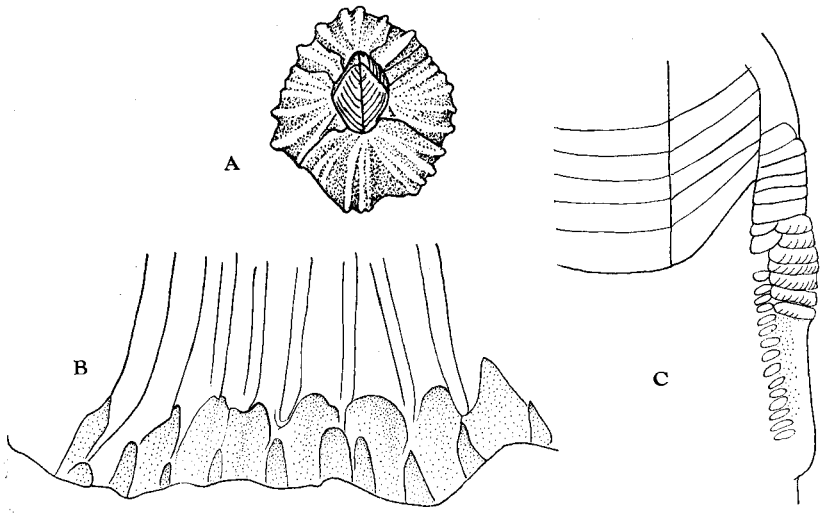
Supplementary Description: The shell is usually tubulo-conical, with a broad rhombic orifice hardly toothed. The exterior of the parietes is prominently ribbed; the interspace between these white ribs is colored dark Indian red to dark purple, but often some of these ribs are barely raised; if so, the parietes are partly smooth and simply longitudinally striped.

The radii are very broad, purplish or pink tinted and their summits are moderately oblique. Sutural edges of the radii are strongly septate transversely, each septum being denticulate downwards.

Internally, the sheath is rather short and the face of the inner lamina is strongly ribbed all throughout. These inner ribs are slightly fluted on both sides and bluntly terminate at the basal margin and then continue to the longitudinal septa separating the parietal tubes. These parietal tubes have numerous transverse septa in the

upper part, but in the lower half they are rather large and open. The longitudinal septa between the tubes bifurcate at their bases close to the outer lamina, forming one or two subsidiary pores between the larger primary pores; both pores are relatively large and squarish to triangular at base. These primary and secondary parietal tubes correspond to the purple stripes or furrows between the ribs on the outside.

The scutum is wider than long, with a broad dark purplish triangular pattern on the outside. The interior is usually roughened with tubercles in the upper part. The pit for the adductor muscle is distinctly doubled and the pit for the lateral depressor muscles is also distinct. The articular ridge strongly projects beyond the



Text-fig. 4. *Balanus albicostatus albicostatus* PILSBRY from Hatake-zima, Tanabe Bay. A, shell, upper view. B, basal part of lateral compartment, inner view. C, part of rostrum, showing sutural edge, inner view. A, ×1.5; B-C, ×9

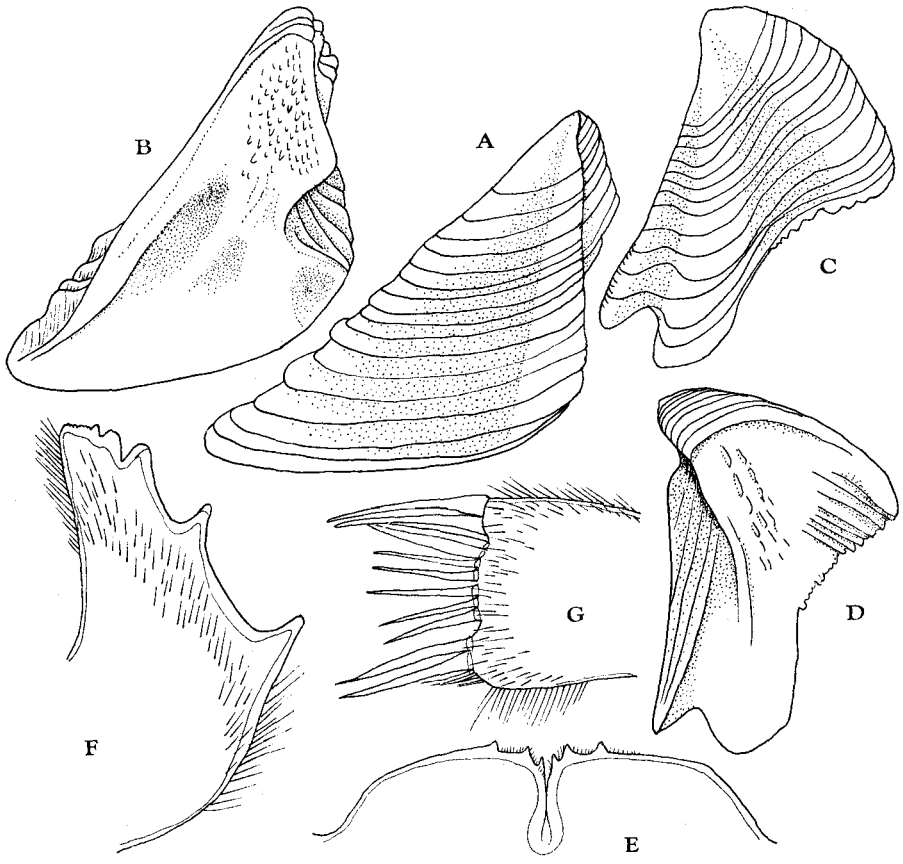
tergal margin, forming a trinagular lobe and internally is strongly reflexed and rectangularly ended over the broad articular furrow.

The tergum is roughly of equilateral triangle or moderately narrower, with 2 purplish patterns radially running on the flat outside. The spur is short, roundly ended and separated by less than its own width from the basi-scutal angle. The interior is smooth or roughened in the upper part and provided with many crests for the depressor muscles along the straight or slightly concave basal margin, becoming dentate towards the base of the spur.

Habitat: Exclusively on intertidal stones, rocks or moles in quiet inner bays and harbors protected from rough surf. This barnacle is most tolerable to long desiccation like *Chthamalus challengeri* occurring on high tide levels.

Distribution: Known only in Japan, Korea and China, northward to Mutu Bay of Honsyu.

Remarks: This barnacle was originally regarded by PILSBRY (1916) as a variety of *B. amphitrite* following the current concept on the variability of the species.



Text-fig. 5. *Balanus albicostatus albicostatus* PILSBRY from Hatake-zima, Tanabe Bay.
A, scutum, outer view. B, scutum, inner view. C, tergum, outer view. D, tergum, inner view. E, labrum. F, mandible. G, first maxilla. A-D, ×12

However, if HARDING's procedure is followed, it must be regarded as a distinct species, somewhat related to *B. venustus* in the shape of the opercular valves and in having 3 pairs of teeth in the labrum rather than *B. pallidus* (including *stutsburi*) as PILSBRY at first thought. But the above-mentioned peculiarity in the parietal tubes of the wall represents to be specifically different.

5. *Balanus albicostatus formosanus* HIRO (emend.)
(Japanese name: Taiwan-huzitubo)

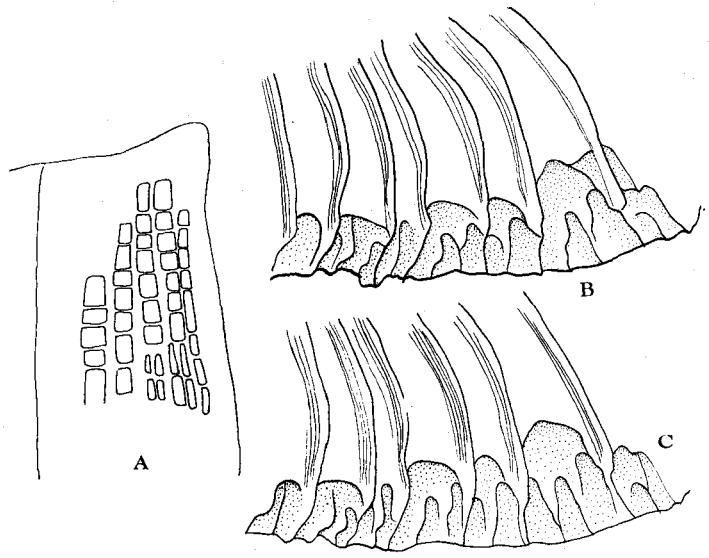
(Text-figs. 6–7 and Plate VI, fig. 3)

B. amphitrite forma *formosanus* HIRO, 1938, p. 306, figs. 6–7—Rokuko (Luchiang), Gosei (Wuchi) and Tanshui Estuary.

B. a. albicostatus: HIRO, 1939, p. 261, fig. 8B—Toi near Kiirun (Kilung), Tanshui, Rokuko (Luchiang), Gosei (Wuchi) and Takao (Takou or Kaohsiung) (all of Taiwan).

Not *B. a. formosanus*: KOLOSVÁRY, 1962e, p. 199, fig. 1 (tergum only)—Karakum desert, Caspian Region (fossil).

Syntype: SMBL-Type 21 (specimens from Rokuko, Taiwan) deposited in the museum of the Seto Marine Biological Laboratory.



Text-fig. 6. *Balanus albicostatus formosanus* HIRO from Luchiang, Taiwan. A, upper part of eroded lateral compartment, showing parietal tubes with transverse septae, exposed. B-C, basal part of compartments, inner view. All ×9

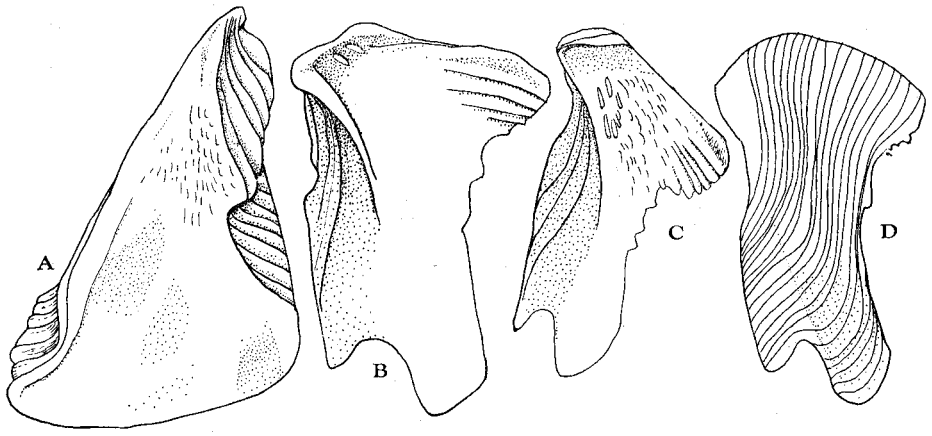
Material Examined: (1) Luchiang (Syntype—SMBL-Type 21). Coll. Dr. Hayato SATO, 1936. (2) Luchiang. Coll. H. UTINOMI, 1938. (3) Wuchi. Coll. Dr. Hayato SATO, 1936. (4) Tanshui Estuary. Coll. Dr. D. MIYADI, 1937 and H. UTINOMI, 1938. (5) Takou (Kaohsiung). Coll. H. UTINOMI, 1938.

Supplementary Description: The shell of the specimens aggregated on oyster shells is generally tubulo-conical, with a large rhombic orifice. Externally the parietes are nearly smooth, whitish, and marked with barely raised, wide white ribs between which the furrows are wider and evenly dark rose or marked with a

number of the same colored longitudinal stripes. These barely raised white ribs are never so prominent as in the typical *albicostatus* and much fewer, when the narrow white stripes between them are not counted.

The radii are broad, purplish, with oblique summits, and their sutural edges are transversely septate.

Internally, the sheath is short, less than one-half of the height and colored dark purple. The face of the inner lamina below the sheath is strongly ribbed all throughout. These inner ribs are flattopped and much fluted on both sides. They continue to the thin longitudinal septa between the parietal tubes, without protruding at their ends, although the basal margin of the inner lamina between these ribs is strongly concave.



Text-fig. 7. *Balanus albicostatus formosanus* HIRO from Tanshui, Taiwan.
A, scutum, inner view. B-C, tegum, inner view. D, tergum, outer view. All ×12

The parietal tubes are transversely septate in the upper part of the parietes, as can be seen from outside in much eroded shell. The parietal pores shown at the base of the wall is much more complex than in the preceding *albicostatus* from Japan, the secondary pores formed close to the basal edge of the wall being intercalated deeply within the primary pores (compare figs. 4B and 6B-C).

The scutum is externally flat, uncolored, with broadly reflexed articular ridge; internally slightly roughened in the upper part. The adductor ridge is widely separated from the lower end of the articular ridge and rather low, while the depression for the adductor muscle is deep and elongated in parallel to the occludent ridge; the pit for the lateral depressor muscle is distinct or obsolete.

The tergum is externally flat, rather narrow and long; internally deeply sunken from the articular ridge and roughened with many tubercles. The spur is rather long, slightly tapering to the obliquely truncated end and is well away from the basi-scutal angle. The basal margin, often confluent with the carinal margin of the

spur, is slightly concave towards the basi-carinal prolongation which bears internally about 5 crests for the depressor muscles and some obtuse teeth along the basal concavity.

Habitat: Aggregated on wharf piles, rock-oysters on protected coasts or ports where are exposed during low tides.

Distribution: Hitherto known only from the north and west coasts of Taiwan (Formosa).

Remarks: This form was originally described by myself (HIRO, 1938) as a local form of *B. amphitrite* in the broad sense, related to the Japanese form *albicostatus* PILSBRY, but later (HIRO, 1939) merged to the latter, considering the latter a subspecies. Now, from the alleged close relationship this Formosan form should be treated as a subspecies of *B. albicostatus* raised to the specific rank. The intralaminate figure of both forms is similar and quite different from that of the other smooth-walled species with one-layered parietal pores.

6. *Balanus variegatus cirratus* DARWIN
(Japanese name: Amime-huzitubo)

(Text-fig. 8)

B. amphitrite var. (9) *cirratus* DARWIN, 1854, p. 241, pl. 5, fig. 2b—Mouth of Indus, Australia and Philippines.

B. a. cirratus: NILSSON-CANTELL, 1921, p. 316, fig. 65—Hongkong and Sunda Is. (on mangrove-roots); NILSSON-CANTELL, 1931, p. 111—Santuao, Fokien of South China (on shells); NILSSON-CANTELL, 1934b, p. 56—Batavia (on shells); NILSSON-CANTELL, 1938b, p. 40—Orissa coasts, etc. of India (on shells and wood); HIRO, 1938, p. 302, fig. 2—Iki Is., Ariake Sound, west coast of Korea, Takou (Taiwan); HIRO, 1939, p. 262—Rokuko (Luchiang), Anping and Takou (Kaohsiung); UTINOMI, 1949, p. 22—Iki Is. (on bamboo) and Misumi (on gastropod shells); UTINOMI, 1962, p. 216—Nomosaki (on angler-ropes); ZEVINA and TARASOV, 1963, p. 89, fig. 10—Lüta, Yantai, Tsingtao, Chau Chwang and Hainan Is.

B. variegatus var. *cirratus*: HARDING, 1962, p. 293, pl. 10, figs. 1–0—Mouth of Indus (on gastropod shell).

? *B. a. vladivoskensis* TARASOV and ZEVINA, 1957, p. 184, fig. 67—Vladivostok.

Not *B. a. cirratus*: POPE, 1945, p. 362, pl. 28, figs. 5–6 and pl. 29, fig 6 and pl. 30, figs. 13–14—Port Jackson, Australia [=*B. variegatus variegatus* DARWIN].

Not *B. variegatus* var. *cirratus*: POPE, 1966, p. 179—Port Phillip Bay, Australia [=*B. variegatus variegatus* DARWIN].

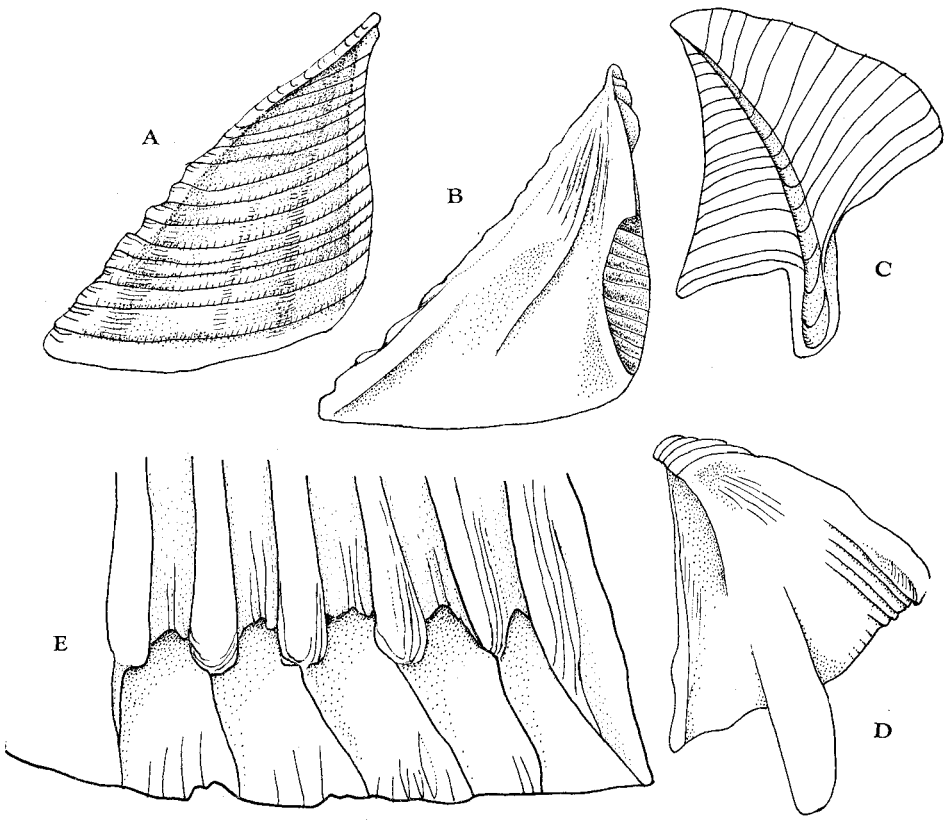
Lectotype: B.M. 1961. 61. 12. 6. 82 C (from Mouth of Indus) deposited in the British Museum (Nat. Hist.), London.

Material Examined: (1) Takou (Kaosiung), Taiwan. Attached to small bivalve shells *Aloides flava*. Coll. Mr. Ai YAMAGUCHI. (2) Takou Port, Taiwan. Attached to submerged wracks at the Hagihara Dockyard. Coll. H. UTINOMI, 1938. (3) Anping Port, Taiwan. From wooden ships foulings. Coll. H. UTINOMI, 1938. (4) Misumi, mouth of Ariake Sound, Kyusyu. Attached to shells of a gastropod

Rapana thomasiana taken at low tide. Coll. H. UTINOMI, 1936. (5) Pyengyang Fish Market, North Korea. Attached to the carapace of a crab *Orithyia sinica*. Coll. Dr. T. KAMITA, 1934.

Supplementary Description: The shell is conical or tubulo-conical, with a large, rhombic orifice, moderately toothed around the apex.

The parietes are quite smooth, whitish buff in ground color and marked with narrow, light purplish brown longitudinal stripes which are intersected by horizontal



Text-fig. 8. *Balanus variegatus cirratus* DARWIN from Takou, Taiwan.
A, scutum, outer view. B, scutum, inner view. C, tergum, outer view. D, tergum, inner view. E, basal part of lateral compartment, inner view. All ×12

bands of the same color, both being equidistantly spaced. The radii are broad, uniformly whitish buff, with oblique summits. Their sutural edges are transversely septate. Internally, the sheath occupies more than one-half of the height of the parietes, and below it the face of the inner lamina is strongly ribbed. These ribs are rather low, fluted on both sides and protruding below just before continuing to the narrow longitudinal septa between the parietal tubes. The parietal tubes are

arranged in one row and their basal openings are broad and rectangular in outline and further a few small secondary riblets (about 1–5 per pore, approximately 1 mm wide) and many denticles are intercalated between the primary septa along the basal margin of the outer lamina.

The scutum is concave externally with a pink or purplish brown pattern in the middle; the growth-lines are prominent and minutely beaded along which the persistent overlying epidermis is hairy; internally the articular ridge is high but weakly reflexed; the adductor ridge is distinctly away from the articular ridge by a deep pit inserted between; the pit for the lateral depressor muscle is distinct.

The tergum is approximately equilateral-triangular, with a narrow long spur lying in midway of the straight basal margin, right-angled. Externally a narrow, semi-open furrow runs from the apex to the end of the spur; internally there are 4 short but prominent crests for the carinal depressor muscles.

Size. One of the largest specimens here examined in the isolated condition measures as follows: Carino-rostral diameter 20 mm, height 11 mm, greatest orificial diameter 11 mm.

Habitat: Usually attached to intertidal or upper subtidal molluscan shells and other benthic animals living on sandy botton.

Distribution: Hitherto known with certainty from Australia, northern coasts of the Indian Ocean, Malay Archipelago, Singapore, Philippines, Taiwan (Formosa), China and west coasts of Kyusyu and Korea, not extending eastwards along the Pacific coast of Japan.

Remarks: HARDING (1962), after re-examining DARWIN's material in the light of modern usage of nomenclature, has raised Darwin's var. *variegatus* to the specific rank and treated this *cirratus* as a variety within it. This procedure seems to be reasonable morphologically. But now I treat it as a subspecies, as done for the varieties or subspecies closely allied to *B. venustus* s. str. No further discussion may be needed.

7. *Balanus reticulatus* UTINOMI, nom. nov.

(Japanese name : Sarasa-huzitubo)

(Text-figs. 9–12 and Plate VI, figs. 7–8)

B. amphitrite var. (1) *communis* DARWIN, 1854, p. 240, pl. 5, figs. 2*e*, 2*h* and 2*l* (partim).

? *B. a.* var. (1) *communis*: HOEK, 1913, p. 168, pl. 14, figs. 12, 14* and 16—Siboga St. 2, Madura Strait, 56 m; Batavia (on bambusa).

Not *B. a. communis*: NILSSON-CANTELL, 1921, p. 311, fig. 64—Mindanao, Biliton and Java Sea (on mangrove roots and barks) [=*B. amphitrite amphitrite* DARWIN sensu HARDING]

B. a. forma *communis*: BROCH, 1922, p. 314—Manila Bay, 5 fms. and off Jolo, 20–30 fms.; BROCH, 1931, p. 58—Lampong Bay, 25 m, Gulf of Siam, 12 m, Sound at Koh Chang, 6–10 m.

Not *B. a. communis*: NILSSON-CANTELL, 1931, pp. 110, 122, fig. 3—Mediterranean Sea (on molluscan

shells) and Cape of Good Hope (on woods); NILSSON-CANTELL, 1938b, p. 36, fig. 7—Portuguese East Africa and various localities of India.

B. a. communis: HIRO, 1938, p. 301, fig. 1—various localities of Japan.

? *B. a. communis*: KOLOSVÁRY, 1939, p. 129, figs. 1–65 (account on variation of opercular valves, cited from various resources).

B. a. communis: UTINOMI, 1956, p. 52, pl. 26, fig. 11 (colored); UTINOMI, 1960, p. 44, figs. 1*c*, 1*d*, 2*c* and 2*d* (comparison with *B. hawaiiensis* BROCH (=*B. amphitrite amphitrite* D.); STUBBINGS, 1961a, p. 173—Persian Gulf (on oyster-shells from piers); STUBBINGS, 1961c, p. 205, figs. 3, 6, 9 and 13—fossils from Kaspi and Aral Neogene.

B. a. variety: SOUTHWARD and CRISP, 1963, p. 43, fig. 23 (colored)—West Indies (on oyster).

B. a. tesselatus UTINOMI (nom. nov.), 1964, p. 52, pl. 26, fig. 11 (colored).

B. variegatus tesselatus UTINOMI (nom. nov.), 1966, p. 5 (listed only)—Tomioka and Nomosaki, Kyusyu.

Not *B. tessellatus* SOWERBY, 1818, Mineral Conchol., pl. 84 [=*Balanus balanus* (LINNÉ, 1758)].

Lectotype (Pl. VI, figs. 7–8): A complete typical specimen selected from many specimens taken from test panels suspended at a depth of 5 m at Tatigatani, Tanabe Bay, Wakayama Pref., Japan. Coll. H. UTINOMI, 3 June, 1934. Deposited in the museum of the Seto Marine Biological Laboratory, registering as SMBL-Type 199.

Size of lectotype. Carino-rostral diameter 26 mm, height 15 mm, greatest orificial diameter 10 mm.

Material Examined: (1) Tatigatani, Tanabe Bay, Wakayama-ken, Japan. Many specimens attached to test slate panels or cultured oysters suspended from rafts at various depths. Coll. 1934~1965. (2) Ago Bay, Mie-ken, Japan. Many specimens attached to test panels for fouling organisms. Coll. Dr. Shizuo MAWATARI, 1952 and Dr. Tatuo KAWAHARA, 1958.

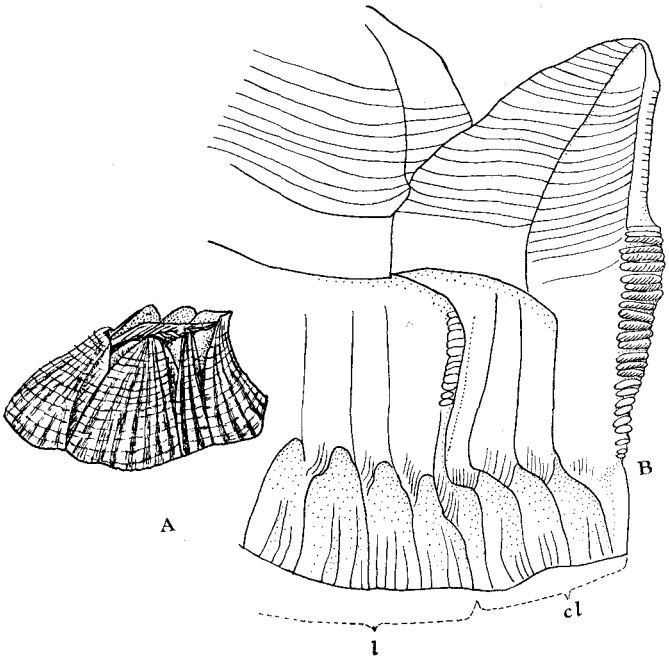
Supplementary Description (Also see HIRO, 1938, p. 301 and UTINOMI, 1960, p. 47): The shell is typically conical, with a comparatively small, rhomboidal orifice, strongly toothed around, when isolated. So the base often tends to conspicuously expand relatively to its height. The apex of all compartments, especially the carina, is often turned outwards, thus showing a concave profil in lateral aspects.

The ground color of the shell is reddish gray, darkened with bluish tint in the upper part, and the parietes are externally quite smooth, polished and ornamented with rather broad dark purple longitudinal stripes equidistantly which are intersected by many narrower reddish brown and white horizontal lines alternately.

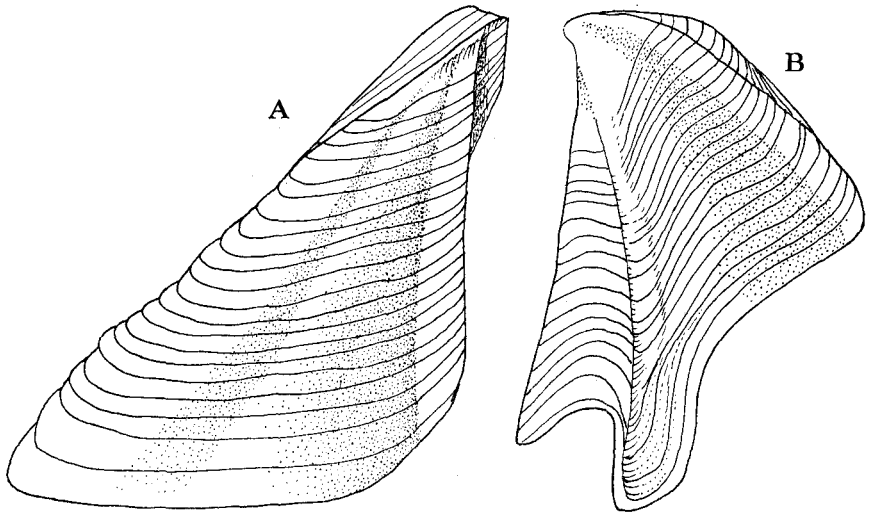
The radii are narrow, with very oblique summits; they are generally white, freckled with reddish brown spots. The sutural edges are transversely septate, each septum being denticulate downwards.

Internally, the sheath is broad, nearly one-half as long as the paries, and its lowest part is quite smooth, lacking transverse striations, and its basal edge is not free from the inner face of the wall. The inner lamina below the sheath is rather weakly ribbed. These inner ribs do not protrude at the bottom of the inner lamina, although slightly denticulate on both sides at the transition to the thin longitudinal septa connecting both the inner and outer laminae.

The parietal tubes are arranged in one row and devoid of any transverse septa



Text-fig. 9. *Balanus reticulatus* UTINOMI, nom. nov. from Tatigatani, Tanabe Bay.
A, shell, side view. B, carino-lateral (*cl*) and lateral (*l*) compartments connected together, inner view. A, ×1.3; B, ×9

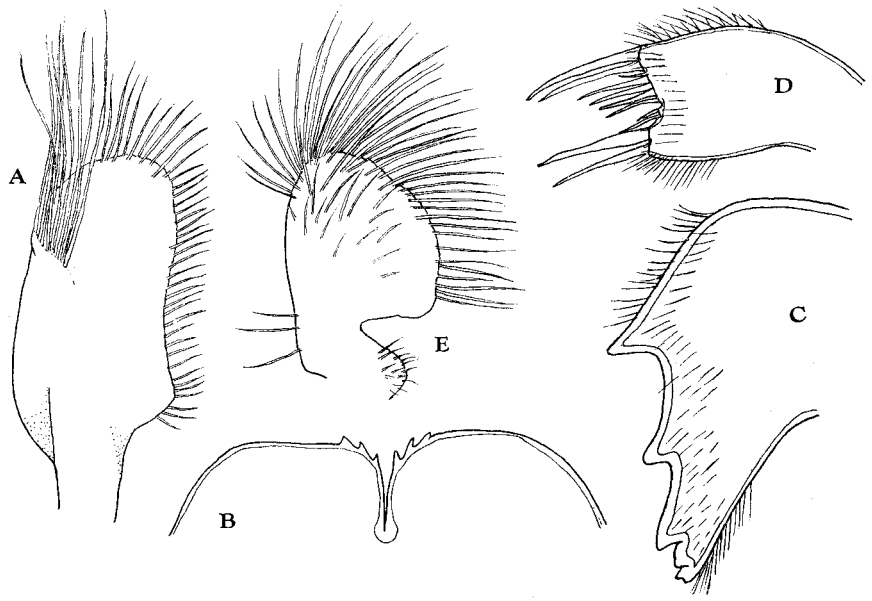


Text-fig. 10. *Balanus reticulatus* UTINOMI, nom. nov. from Tatigatani, Tanabe Bay.
A, scutum, outer view. B, tergum, outer view. All ×12

up to the tip of the wall. Basally, their openings are eonsiderably large and radially elongated rectangular in section, and many incomplete septa or riblets are present on the inner face of the outer lamina. Apparently these subsidiary septa are elevated on the wall apart from the basal margin, thus they may not serve as the "teeth" locking the calcareous basis.

The scutum is flat externally and colored dull purple in the middle. Internally, the articular ridge is prominent, about one-half of the tergal margin and the adductor ridge is rather low and short; the pit for the lateral depressor muscle is more or less obscurely defined.

The tergum is externally almost flat, with a very shallow spur fasciole; the basal



Text-fig. 11. *Balanus reticulatus* UTINOMI, nom. nov. from Tatigatani, Tanabe Bay. A, palp. B, labrum. C, mandible. D, first maxilla. E, second maxilla.

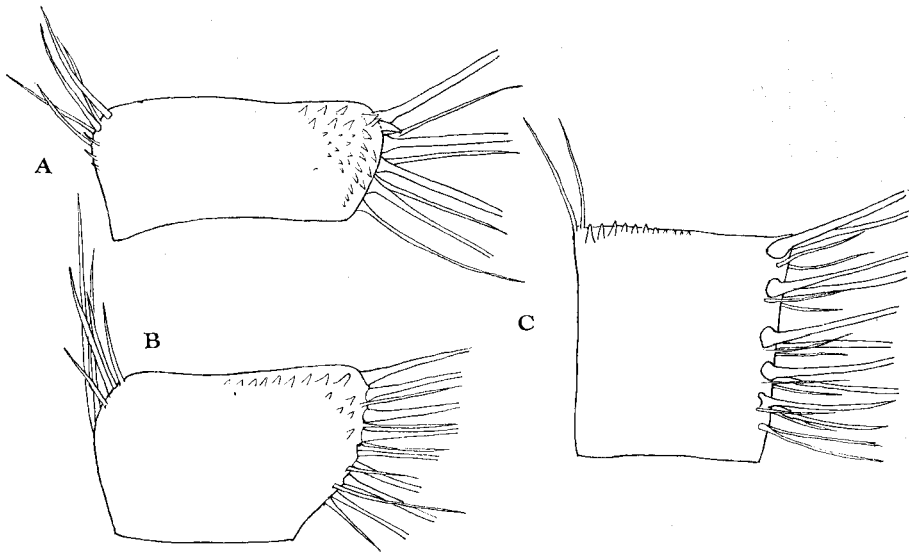
margin is straight, a little longer than the slightly convex carinal margin. The spur itself is rather short, narrow and obliquely truncated at the end; it is approximately its own width distant from the basi-scutal angle and right-angled to the basal margin. The crests for the depressor muscles are not so strong and mostly 5–7 in number.

Mouthparts.—The labrum has invariably 3 teeth on each side of the median notch. The mandible has 3 main teeth and a tripartite lower angle. The first maxilla has 2 large upper, 7 smaller middle and 2 largest lower spines along the frontal margin, of which the lowest angle bearing 2 largest spines is strongly protuberant.

Cirri.—As usual in the *Balanus amphitrite* complex, the first cirrus has unequal rami.

The second and third cirri are equally short in both rami. In the third cirrus, each segment is very short, broad and thickly set with conical spinules and many setae along the frontal border. Of the posterior longer cirri the intermediate segment bears 6 pairs of large setae and one pair of subsidiary small setae between each pair of large ones.

Habitat: Apparently confined to the upper subtidal area, about 2–10 m in depth (most abundant at 5 m deep) and dominated in highly saline bay waters faced to open sea (most abundant between 18.36–18.57 o/oo Cl.). Larval settlement begins late in April and continues until early November but large number of settled juveniles is from June to August, according to cumulative data of fouling tests made



Text-fig. 12. *Balanus reticulatus* UTINOMI, nom. nov. from Tatigatani, Tanabe Bay.
A, 7th segment of cirrus III. B, 11th segment of cirrus III. C, intermediate segment of cirrus V.

in Ago Bay, Mie-ken, Japan, by MAWATARI et al. (1954) and KAWAHARA and IIJIMA (1960).

Distribution: Although indefinitely known due to the confused determination made by earlier authors, this barnacle may probably be widely distributed in all seas of the world and transported by ships. In Japanese waters I formerly recorded from many localities: northerly Ominato Port (Mutu Bay) south to Isigaki-zima (Ryukyu Is.) (HIRO, 1938). Nowadays it seems to be less predominant than *Balanus amphitrite amphitrite* (=*B. a. hawaiiensis*) in many bays or harbours.

Remarks: As mentioned above (p. 201), this presumably widely distributed barnacle has long been confused with *Balanus amphitrite hawaiiensis* or *B. a. denticulata.*,

both established by BROCH much later than the period of DARWIN. Both BROCH's subspecies of *B. amphitrite* have numerous teeth on the labrum.

Concerning this problem, we must point out many obscurities of DARWIN's original definition for the species *B. amphitrite* and its varieties. For example, he gives the diagnoses as follows:——

> *Balanus amphitrite*——Shell longitudinally striped with purple or pink; *sometimes* with the stripes confluent: *sometimes* wholly white. Scutum internally with a prominent broad adductor ridge.
> Var. (1) *communis*——Nearly white, with pale or dark violet-colored longitudinal stripes; epidermis *rarely* persistent; shell *either* thin *or* thick; radii white or freckled with reddish mahogany colour, with their summits *either* oblique, *sometimes* in a high degree, *or* nearly parallel to the basis; basal point of spur of the tergum *either* square *or* bluntly pointed. (*italic* is mine)

And for the mouthparts, he mentions as specific (not either of the varieties) characters as follows:——

> Labrum, with *from* four *to* eight, *generally* six, little teeth: mandibles with three teeth and two minute lower teeth, or mere knobs: maxilla with the edge straight, or with the inferior part forming a slightly step-formed projection. (*italic* is mine)

Next, as seen in DARWIN's Pl. V, figs. 2*e* (lateral aspect of shell, colored), 2*h* (interior of scutum) and 2*l* (exterior of tergum) exactly agree with figs. 9A, 10A and 10B of *Balanus reticulatus* which I propose herein to rename, and by no means correspond to HARDING's Pl. I, figs. *a*, *c* and *f* of the lectotype of *Balanus amphitrite* that he selected from DARWIN's materials still exist in the British Museum. Unfortunately, no mention for these doubtful points was given by HARDING at all. Supposedly the materials figured by DARWIN as "var. *communis*" might had been lost at all.

As for the diagnostic characters used to separate the subspecies of *Balanus amphitrite* complex, HARDING emphasizes that the tergum is of greater diagnostic value than the scutum, while the labrum is very variable, so that of little further value. As to this point I am as before against his view. Indeed, *B. amphitrite* sensu HARDING (syn.: *B. a. hawaiiensis, B. a. denticulata, B. a. franciscanus, B. herzi* and *B. a. saltonensis*) has a multidenticulate labrum. *B. uliginosus* (=*B. a. krügeri*) has invariably 4 teeth on each side of the notch in the labrum. In *B. albicostatus, B. pallidus, B. venustus* (incl. alleged subspecies), *B. variegatus* (incl. alleged subspecies) and *B. reticulatus* here renamed, have normally 3 teeth on each side of the notch, exceptionally 2 teeth on one side only. In *B. peruvianus* described by PILSBRY (1909, 1916) from mangrove swamp in Peru, the labrum is said to have only 2 teeth on each side of the notch.

Of the earlier eminent cirripedologists, apparently NILSSON-CANTELL (1921, 1931 and 1938) seems to have referred the multidenticulate form to DARWIN's var. *communis*, while BROCH (1922 and 1931) seems to have three-denticulate form referred to *communis*.

Apart from the essential disparity in the denticulation of the labrum, many of the specifically important differences in the morphological details and habitat cannot be denied, as formerly enumerated (cf. UTINOMI, 1960, p. 47, Table 2).

In any way, it should be advisable to divide *Balanus amphitrite communis* in Dar-

winian sense into two separate specific ranks. When renaming this reticularly striped form with three-denticulate labrum, I have provisionally given the substitute name *tesselatus* for it (UTINOMI, 1964 and 1966). To my regret, I was quite unaware of the homonymy of the latter at that time. The name *tesselatus* is in any case inadmissible as it is preoccupied by *Balanus tessellatus* SOWERBY, "Mineral Conchology", 1818, Pl. 84, which is a synonym of a different species—*B. balanus* (LINNÉ, 1758). I, therefore, select one of the "*communis*"-like specimens from Tanabe Bay at hand, not in the sense of HARDING (1962) as the type and rename it herein *Balanus reticulatus*, ranking at a specific level.

8. *Acasta spinifera* UTINOMI, spec. nov.
(New Japanese name: Igaguri-kaimenhuzitubo)

(Text-figs. 13–16 and Plate VI, figs. 9–11)

Material Examined: 6 complete specimens imbedded in a silicious sponge *Phakellia foliacea* THIELE, forming gall-like elevations on the upper surface of foliate branch. Off Mera, Tiba-ken, mouth of Tokyo Bay, 70 m deep. Coll. Dr. Minoru IMAJIMA (National Science Museum, Tokyo) and sent me by Miss Yasuyo KAWASHIMA (Research Institute for Natural Resources, Tokyo) for determination.

Types. Holotype (Text-fig. 13 and Pl. VI, fig. 9), registered as SMBL-Type 202. 2 paratypes A and B, registered as SMBL-Type 203. Both are deposited in the museum of the Seto Marine Biological Laboratory. They measure as follows:

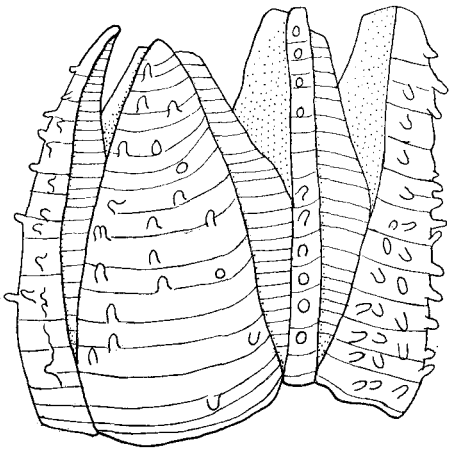
	Carino-rostral diameter	Height
Holotype	6.0 mm	7.0 mm
Paratype A	4.5	5.0
Paratype B	8.0	9.0

Description: The shell is rather fragile, reddish white, especially the upper part of parietes and all radii and alae. The orifice is broad, as large as the basis and strongly toothed. The basis is quite flat, calcareous, very thin, non-porous, smooth inside but concentrically ringed outside.

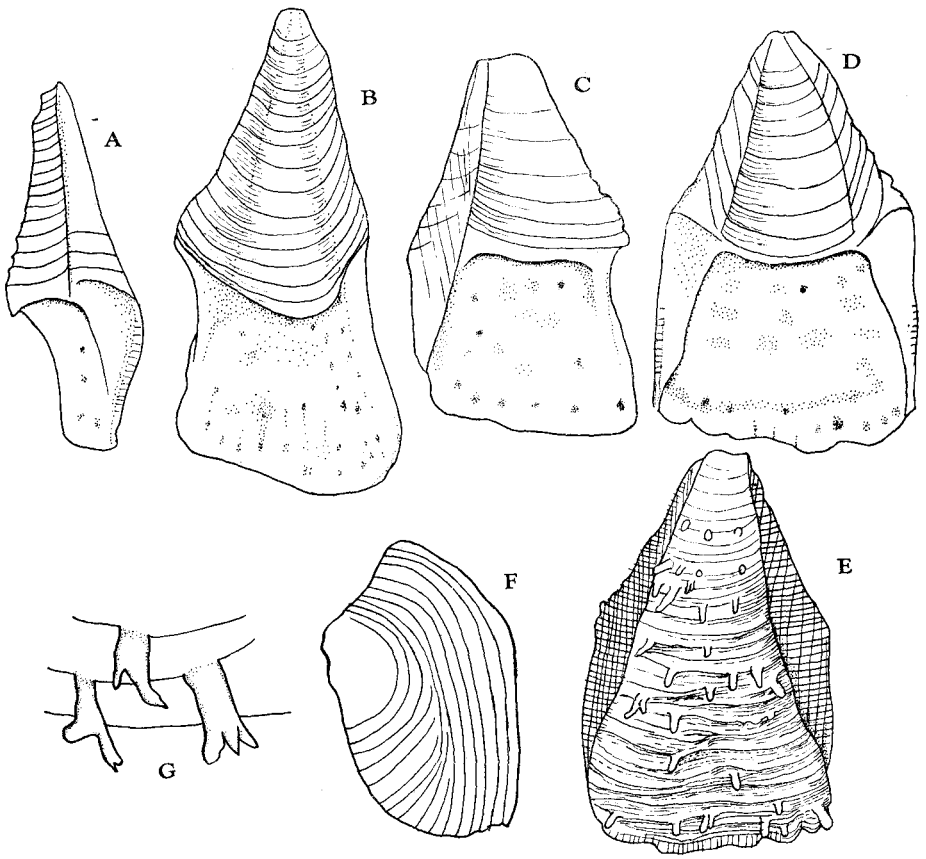
The compartments are well developed, adjoining each other basally. The parietes are solid, externally studded with solid, upturned spines in longitudinal rows or somewhat irregularly. These outer spines are mostly up to 1 mm long (though decreasing upwards in length), obtusely pointed, but often forked at tip.

The carino-lateral paries is the narrowest, about 1/3 as wide as the carinal and lateral paries and about 1/5 as wide as the rostral paries, as shown in the following measurements in millimeters:

		C	CL	L	R
Paratype A	Width	2.5	0.8	2.5	3.0
	Length	6.0	4.5	5.0	5.0



Text-fig. 13. *Acasta spinifera* UTINOMI, spec. nov. Holotype, side view. ×9



Text-fig. 14. *Acasta spinifera* UTINOMI, spec. nov. Paratype A.
A, carino-lateral compartment, inner view. B, carina, inner view. C, lateral compartment, inner view. D, rostrum, inner view. E, rostrum, outer view. F, part of basis, outer view. G, forked spines. A-F, ×12; G, ×14

Paratype B	Width	4.8	1.0	4.0	5.0
	Length	8.0	7.0	8.2	9.0

Internally, the sheath in all parietes is broad, occupying the upper half of the height and transversely striated rather coarsely and its lower edge is free from the wall. The inner face below the sheath is not ribbed but scatteredly pitted at the position of the outer spines.

The radii and alae are very broad, with obliquely sloping upper edges and transversely striated; all sutural edges are minutely septate.

Opercular valves.—The scutum is moderately thick, higher than wide and sculptured with strong radial ridges crossed on the growth-lines along which the overlying yellowish epidermis is hairy. Internally, the articular ridge is prominent, longly curved over the broad articular furrow; apparently there is no distinct depression for the adductor and lateral depressor muscles.

The tergum is triangular, about as long as wide, with a beaked apex and a short spur; the exterior is quite flat, marked with smooth growth-lines widely spaced and fringed with hairs; there is a prominent open furrow running from the apex to the obliquely truncated end of the spur which is distant from the basi-scutal angle by about one-half its own width, forming a right angle. Internally, the articular furrow is very wide and no crests for the depressor muscles.

The *cirri* in the paratype specimen B dissected show the following numbers of segments:

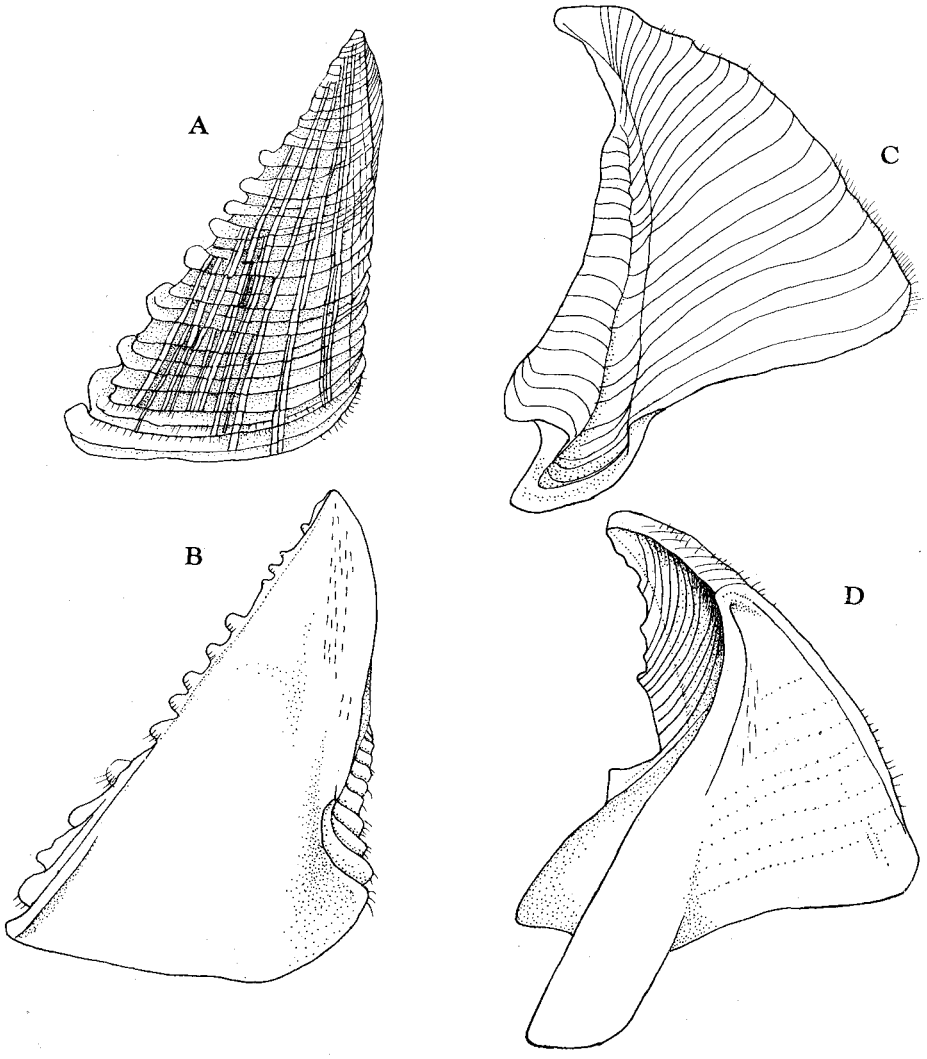
I	II	III	IV	V	VI
9 7	11* 15	28 28	15* 23	27 28	27 27

* mutilated distally.

In cirrus I, the anterior ramus is a little longer than the posterior. In cirri II and III, both rami are subequal. In cirrus IV, neither hooks nor spinules are present on segments of both rami, as in the posterior pairs of cirri V and VI, and only furnished with three pairs of setae on the frontal convex margin and a tuft of 1–3 shorter setae at the dorso-distal corner.

The penis is long, annulated all throughout, but devoid of hairs and basi-dorsal point.

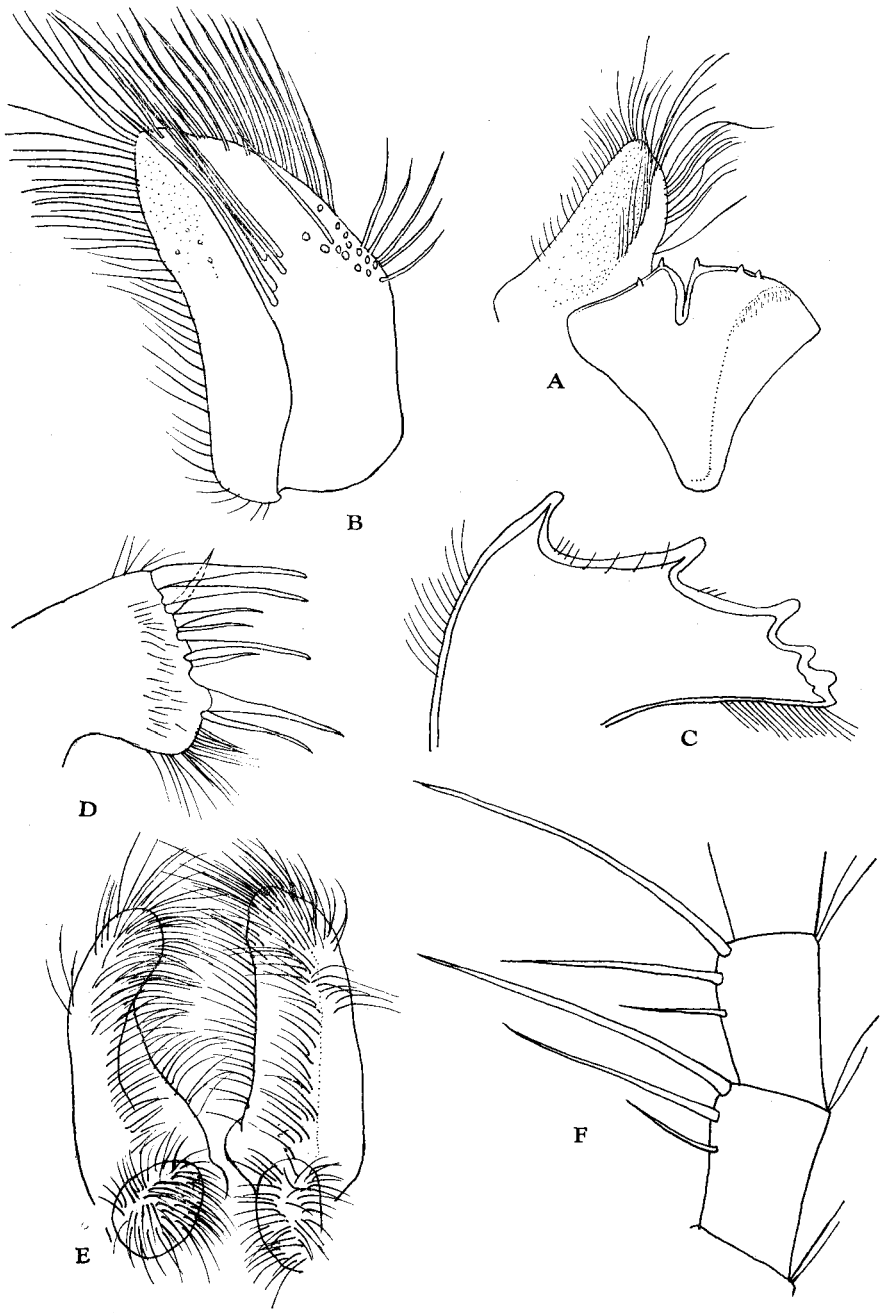
Mouthparts.—The labrum has only 2 denticles on each side of the median notch. The palp is elongate, spoon-shaped and profusely setose. The mandible has 5 teeth and a shortly pointed lower angle. The first maxilla has 2 large upper spines followed by 5 smaller spines in the middle part and 2 larger spines in the lower part along the almost straight frontal margin, terminating by a tuft of a few spinules. The second maxilla is bilobed, the upper lobe being elongate and the lower lobe small and oval, both densely setose along the inner margin.



Text-fig. 15. *Acasta spinifera* UTINOMI, spec. nov. Paratype B.
A, scutum, outer view. B, scutum, inner view. C, tergum, outer view. D, tergum, inner view. All ×10

Remarks: In external appearance, this barnacle seems to be most closely allied to *Acasta cyathus* DARWIN hitherto known from Madeira, West Indies, Florida and (?) the Gulf of Manaar, India and also to *Acasta scuticosta* WELTNER (1887) known only from Cartagena, Spain in the shape of the opercular valves, but evidently different from both in the details of of peculiar structure described and illustrated above.

The absence of hooks or spinules in the fourth cirri in this species shows to be an aberrant form belonging to BROCH's "Inarmata group".



Text-fig. 16. *Acasta spinifera* UTINOMI, spec. nov. Paratype B.
A, labrum and palp. B, palp. C, mandible. D, first maxilla. E, second maxillae. F, iatermediate segments of posterior ramus of cirrus IV. A, ×67; B-E, ×63; F, ×97

9. *Creusia indica* (ANNANDALE)

(Japanese name : Hosi-sangohuzitubo)

(Text-figs. 17–18 and Plate VI, figs. 12–16)

Creusia spinulosa LEACH, var. (11) DARWIN, 1854, p. 381, pl. 14, figs. 6*U* and 6*u*—Singapore.
? *Creusia spinulosa* var. (11): HOEK, 1913, p. 265—Siboga St. 257.
Creusia spinulosa LEACH forma *angustiradiata* BROCH, 1931, p. 118—Kei Islands.
Pyrgoma indicum ANNANDALE, 1924, p. 64, pl. 12, fig. 10—Mergui Archipelago.
Creusia spinulosa LEACH forma *angustiradiata*: NILSSON-CANTELL, 1938b, p. 62, pl. 3, fig. 1 and text-fig. 23—Mergui Arch.; HIRO, 1935, p. 51, fig. 3—Tanabe Bay; HIRO, 1938b, p. 399—Palao; UTINOMI, 1943, p. 16, figs. 1–4 (larval stages)—Tanabe Bay.
Pyrgoma indicum: UTINOMI, 1962, p. 227—Nomosaki.
Creusia indica: UTINOMI, 1966, p. 7—Nomosaki.

Material Examined: Two large specimens (Pl. VI, figs. 12–13) imbedded in the coral *Platygyra lamellina* (EHRENBERG) from Kusimoto, Wakayama-ken (purchased, 1966) and many shells from faviid corals collected in Tanabe Bay.

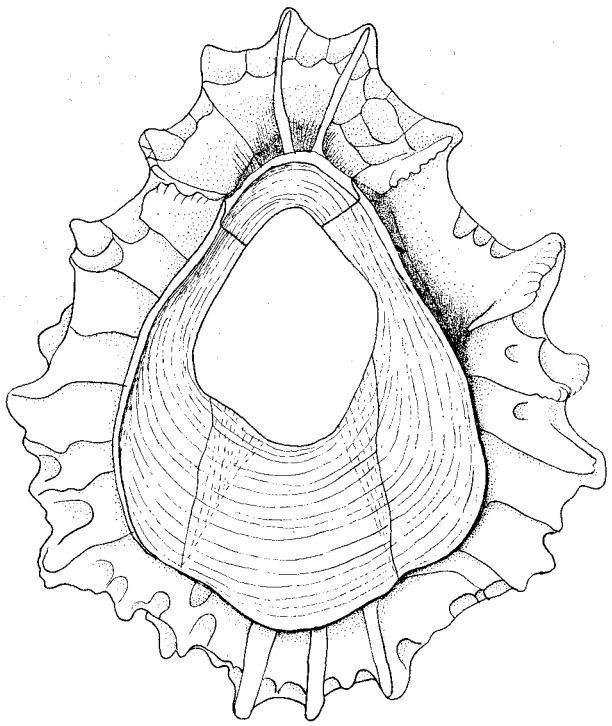
Size of Largest specimens. Carino-rostral diameter of shell 18 mm; Longest diameter of orifice 3 mm; width of shell 13 mm; depth of basis 22 mm.

Supplementary Description: Of the two large specimens figured here, one has a nearly flat shell exposed wholly on the surface of the host coral, while the other has a slightly conical shell partly exposed. Both are provided with about 31 prominent ribs radiating from the apex around the orifice and strongly plicated toward the circumference. These ribs are high, narrow and crenulated at tip.

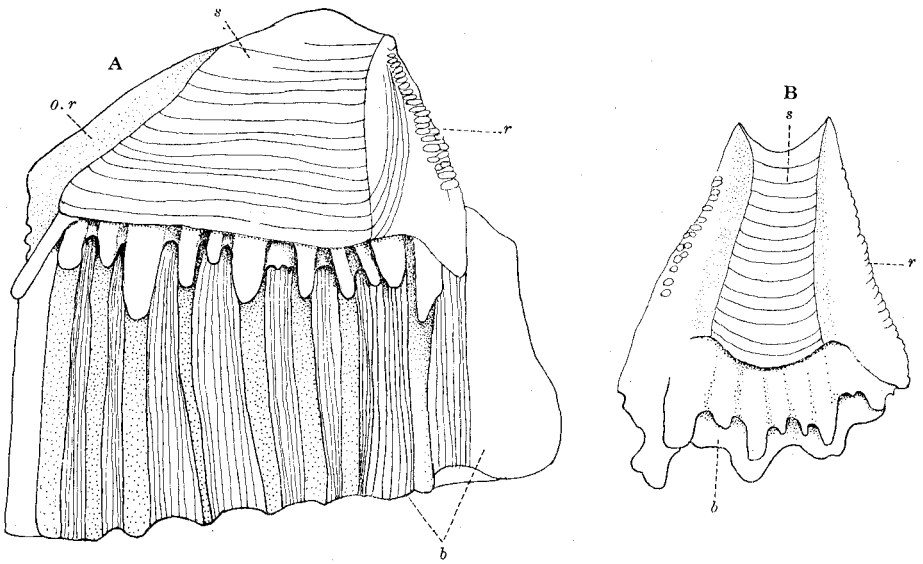
The shell is white tinged with rosy hue. Externally there are no trace of radii, thus the four compartments are completely fused together.

In internal aspect, however, there are four distinct sutures on the finely striated broad sheath which occupies the upper two-thirds of the length of the wall. The rostrum is intermediate in width between the carina and lateralia, although its own width is variable in specimens. The lower edge of the sheath is quite free from the inner wall. The sutural edges of the wall-plates are simply dentated as in other Balanomorph barnacles. The inner surface of the wall below the sheath is deeply hollowed and more or less distinctly costate toward the marginal dentations. The hollow between the costae is of ten here and there permeated by several rows of pores. However, these pores, when present, are confined only to the basal margin, never extending upwards like such parietal tubes as seen in ordinary *Balanus*, the wall plate being essentially solid.

In the initial stage of shell development, the 4 shell-plates are completely separated and their wall is quite solid (though thin) without any distinct demarcation of the sheath and the inner wall (cf. UTINOMI, 1943). In more advanced stages of calcification, the sheath and the marginal wall are connected together by the inner costae. If the sheath is interpreted as the "inner lamina" not developing the lower wall



Text-fig. 17. *Creusia indica* (ANNANDALE). Inner view of shell. ×9



Text-fig. 18. *Creusia indica* (ANNANDALE) from *Platygyra lamellina*.
A, lateral compartment and part of porous basal wall, inner view. B, rostrum and part of poreless basal wall, inner view. All ×9
b—basis; *o.r*—outer rib on shell; *r*—radius; *s*—sheath.

and the marginal wall as the true "outer lamina", these connecting ribs may correspond to the "primary longitudinal septa" of ordinary barnacles and hence the marginal basal pores may be interpreted as the secondary pores formed at the base of the "outer lamina".

The discussion presented here may be too much speaking, since apparently similar case is met with in the other Balanomorphs such as *Balanus* (*Semibalanus*), *Tetraclita* (*Tesseropora*), *Chelonibia* and *Platylepas*, all with membranous basis (also see Ross and NEWMAN, 1967). In any way, such abnormally perforated structure may depend on a secondary phenomenon occurring in the process of calcification or marginal growth.

The wall of the basal cup imbedded deeply in the coral skeleton is either solid or porous. In the latter case, the inside of the basal wall is prominently ribbed. These ribs, which contain empty longitudinal tubes within, are finely striated on the surface, and the marginal projections or denticles of the shell-wall tightly interlock with the deep furrows between these ribs at the top of the basal cup.

Habitat and Distribution: Widely distributed in the Indo-west-Pacific area, harbouring commonly on astraeid or meandroid reef corals, such as *Favia speciosa, Favites favosa, Platygyra lamellina, Lithophyllon lobata, Caulastrea tumida, Leptastrea purpurea, Echinophyllia aspera, Hydnophora exesa, Merulina ampliata, Acanthastrea echinata, Lobophyllia robusta, Symphyllia recta, Pectinia lactuca,* etc.

10. *Megatrema oulastreae* (UTINOMI)
(Japanese name: Toge-sangohuzitubo)

(Text-figs. 19–20)

Pyrgoma anglicum: HIRO, 1935, p. 53 (Fig. 4 is real *Pyrgoma* (*Megatrema*) *anglicum* SOWERBY, attached to *Caryophyllia smithi* from Plymouth, England); HIRO, 1937, p. 467—Tanabe Bay (on *Psammocora*).

Creusia spinulosa LEACH forma *quarta*: UTINOMI, 1949, p. 35, fig. 6—Tomioka (on *Oulastrea crispata*). (not KOLOSVÁRY)

Pyrgoma oulastreae UTINOMI, 1962, p. 227, figs. 6–8—Nomosaki (on *Oulastrea crispata*).

Megatrema oulastreae: UTINOMI, 1966, p. 8 (listed only)—Tomioka and Nomosaki.

Material Examined: (1) Holotype and paratype specimens on *Oulastrea crispata* (LAMARCK) from Nomosaki. Coll. Mr. K. MATSUBAYASHI, 19-III-1961. (2) 6 specimens on *Oulastrea crispata* (LAMARCK) from Bansyozaki, Seto, SW of Tanabe Bay. Coll. H. UTINOMI, 1964. (3) 7 specimens on *Psammocora profundacella* GARDINER from Bansyozaki, Seto, SW of Tanabe Bay. Coll. H. UTINOMI, 1934.

Holotype. Deposited in the museum of the Seto Marine Biological Laboratory, registering as SMBL-Type 187.

Size of Specimens from Seto:

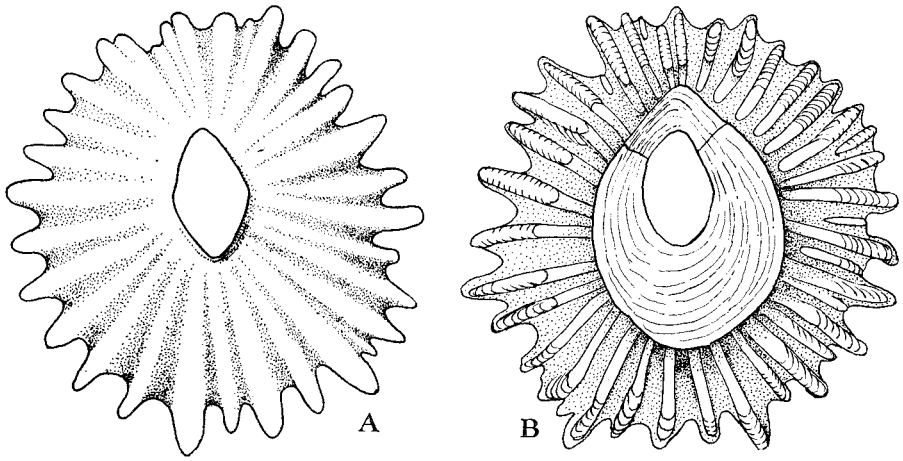
(2) Specimens on *Oulastrea crispata.*

Carino-rost. diam. of shell-wall	Height of shell-wall	Longest diam. of orifice	Depth of basal cup
8 mm	4 mm	2 mm	——
7.5	4	2	4 mm
6	2	2	——

(3) Specimens on *Psammocora profundacella.*

Carino-rost. diam. of shell-wall	Height of shell-wall	Longest diam. of orifice
6 mm	2 mm	1 mm
5	2	1
4	1.7	1
3	1.4	0.8

Supplementary Description: The shell-wall completely covered with the host coral skeleton is low conical or somewhat depressed and nearly round in outline. The outer surface, when cleaned, is radially ribbed and strongly dentated around the circumference.



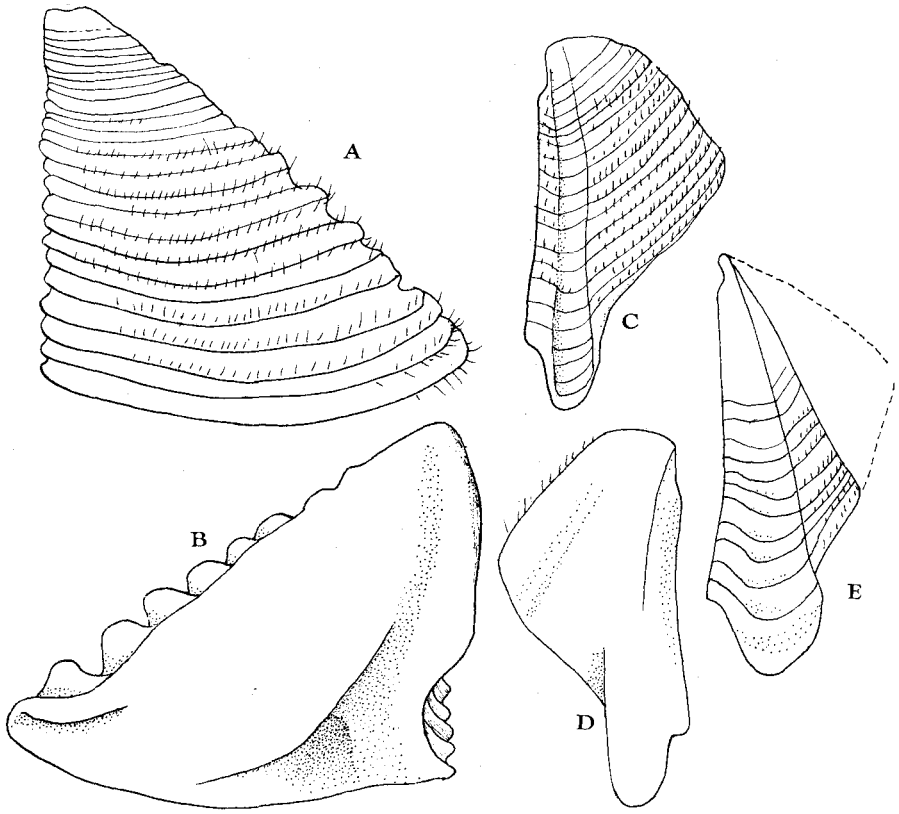
Text-fig. 19. *Megatrema oulastreae* from *Psammocora profundacella.*
A, shell, upper view. B, shell, inner view. All ×12

The wall-plates are completely fused without any trace of sutures externally. The orifice is small, diamond-shaped to oval in outline. Internally, the sheath, occupying about one-half of the height of the wall is finely striated horizontally, and its lower edge is continuous and quite free from the inner face of the wall; there are only two distinct, straight sutures on the sheath separating the small carina from the fused compound compartments (lateralia+rostrum+lateralia). Below the sheath there are many prominent ribs radially arranged along the furrows lying inside of the outer ribs; the number of these ribs counted in one specimen figured here is approximately 31 primaries plus 8 secondaries. These inner ribs are very thick, solid and

denticulate basally toward the marginal edge to connect with the apex of the basis.

The basis is shallow cup-shaped, and porous near the tip but gradually becomes thinner and solid toward the bottom center. The inside of the basis is barely furrowed.

The scutum is wider than high and strongly convex outside. Externally it is covered by an yellowish epidermis and hairy along the rather closely arranged growth-lines; internally, the adductor ridge is prominent, barely reaching the convex basal margin; the articular ridge is long and gently curved.



Text-fig. 20. *Megatrema oulastreae* (UTINOMI) from *Psammocora profundacella*.
A, scutum, outer view. B, scutum, inner view. C, tergum, outer view. D, tergum, inner view. E, partly broken tergum, outer view. All ×33

The tergum is rather narrow, with a short, roundly ended spur, slightly separated from the basi-scutal angle. Externally there is a broad but shallow spur-fasciole and the growth-lines are also fringed with hairs. The interior is quite smooth.

Remarks: Formerly I have referred the low conical specimens partly imbedded in *Psammoqora profundacella* GARDINER to *Pyrgoma anglicum* SOWERBY (HIRO, 1935, p. 53). However, the real *Pyrgoma anglicum* is so far known only from the British waters

(DARWIN, 1854; PILSBRY, 1916; REES, 1962, 1966) and the west African coast (DARWIN, 1854; BROCH, 1927b; STUBBINGS, 1964), harboring on ahermatypic corals such as *Caryophyllia smithi* STOKES & BRODERIP and *Dendrophyllia cornigera* LAMARCK. Later I (UTINOMI, 1962, p. 227) have regarded apparently similar specimens occurred on a hermatypic coral *Oulastrea crispata* (LAMARCK) as a separate species of the genus *Pyrgoma* in the sense of BROOKS and Ross (1960).

However, now I have arrived at a conclusion that the coral-inhabiting corals should be divided into several groups according to the grade of fusiion of compartments in the wall from phylogenetical viewpoint, following a suggestion of NEWMAN and Ross (Ross, 1964 *in litt.*). Although their paper was not yet published, I feel it most timely to present here an example in support of an idea of reviving the taxa rejected by DARWIN and successors on the occasion of redescribing the material here concerned.

The genus *Megatrema* was first erected by LEACH (1825) for *Pyrgoma anglica* SOWERBY (1823) and *Megatrema stockesii* GRAY (1825). These two species have only two sutures on the sheath one on each side towards its carinal end, as do *M. oulastreae*. The three species assignable to *Megatrema* can be differentiated by the following key:

Shell steeply conical, ribbed only at base, with weakly plicated circumference; basis cup-shaped and porous ..... *M. anglica*
Shell low conical, strongly ribbed, with strongly dentated circumference; basis cup-shaped and partly porous ..... *M. oulastreae*
Shell flat, beadedly ribbed, with plain circumference; basis cylindrical and non-porous ..... *M. stockesi*

Habitat and Distribution: Definitely known from southern Japan, harboring on the encrusting reef corals, *Oulastrea crispata* (LAMARCK) and *Psammocora profundacella* GARDINER.

BROCH (1931) referred one specimen on a Fungiid coral from off Toeal, Kei Islands to *Pyrgoma anglicum* with some hesitation, as the shell having distinct radiating ribs all over and at the same time he regarded another dried specimen on a coral taken from deep water (200 m) of Sagami Sea, Japan as "*Pyrgoma* aff. *anglicum* SOWERBY." Inferring from BROCH's note, the former from Kei Islands may be the same as or allied to *M. oulastreae* here described, and the latter from Sagami Sea may be the real *M. anglica* or identical with an unnamed variety of *P. anglicum* which SAKAKURA (1934, p. 575, figs. 1–4) reported from the Pleistocene of Tiba Prefecture where is well known as abundant of fossil corals and located not far from Sagami Sea, as occurring on a simple coral *Heterocyathus* (*Stephanoseris*) *carthausi* FELIX. Besides, the typical *P. anglicum* was recorded by NILSSON-CANTELL (1938b) from Ganjan coast, Madras, Bay of Bengal, 44–45 m, as occurring on *Caryophyllia* sp.

From all earlier records of occurrence it is deduced that *Megatrema anglica* (= *Pyrgoma anglicum*) is probably an obligatory commensal on ahermatypic or deep-sea corals, such as *Caryophyllia, Dendrophyllia, Leptopsammia, Paracyathus, Cladocora,* etc.,

distributing widely in all seas, particularly common on the continental shelf of the eastern Atlantic Ocean. Another little known *M. stockesi* seems to be confined to the West Indies and Florida area, occurring on the hermatypic coral *Agaricia agaricites* (PALLAS).

Acknowledgments

I am indebted to many persons mentioned repeatedly in the text for supplying pertinent material as gifts or on loan during the course of this study, especially to Dr. Torben WOLFF (Copenhagen Museum), Miss Elizabeth C. POPE (Australian Museum, Sydney), Miss Eyvor E. SANDISON (Westfield College, London) and Mr. Arun WAGH (Institute of Science, Bombay) for the type specimens or many local materials abroad. My thanks are also due to Dr. Shin-ichiro FUSE and Mr. Hidetomo TANASE of our Laboratory for the help of photographing the specimens.

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EXPLANATION OF PLATE VI

Fig. 1. *Balanus amphitrite amphitrite* DARWIN sensu HARDING from Tanabe Bay, upper view. ×1.6

Fig. 2. *Balanus albicostatus albicostatus* PILSBRY from Hatake-zima, Tanabe Bay, aggregated. ×1

Fig. 3. *Balanus albicostatus formosanus* HIRO from Luchiang, Taiwan, aggregated. Syntypes. ×1

Fig. 4. *Balanus uliginosus* UTINOMI (nom. nov.) from Omori, Tokyo Bay, aggregated. ×0.7

Fig. 5. *Balanus uliginosus* UTINOMI (nom. nov.) from Tatigatani, Tanabe Bay, upper view. Lectotype. ×1.4

Fig. 6. *Balanus uliginosus* UTINOMI (nom. nov.) from Tatigatani, Tanabe Bay, side view. Lectotype. ×1.4

Fig. 7. *Balanus reticulatus* UTINOMI (nom. nov.) from Tatigatani, Tanabe Bay, upper view. Lectotype. ×1.4

Fig. 8. *Balanus reticulatus* UTINOMI (nom. nov.) from Tatigatani, Tanabe Bay, side view. Lectotype. ×1.4

Fig. 9. *Acasta spinifera* UTINOMI (spec. nov.) from off Mera, mouth of Tokyo Bay, side view. Holotype. ×2

Fig. 10. Rostrum of *Acasta spinifera* UTINOMI (spec. nov.). Paratype B, outer view. ×2.2

Fig. 11. Carino-lateral compartment of *Acasta spinifera* UTINOMI (spec. nov.), Paratype B, outer view. ×2.2

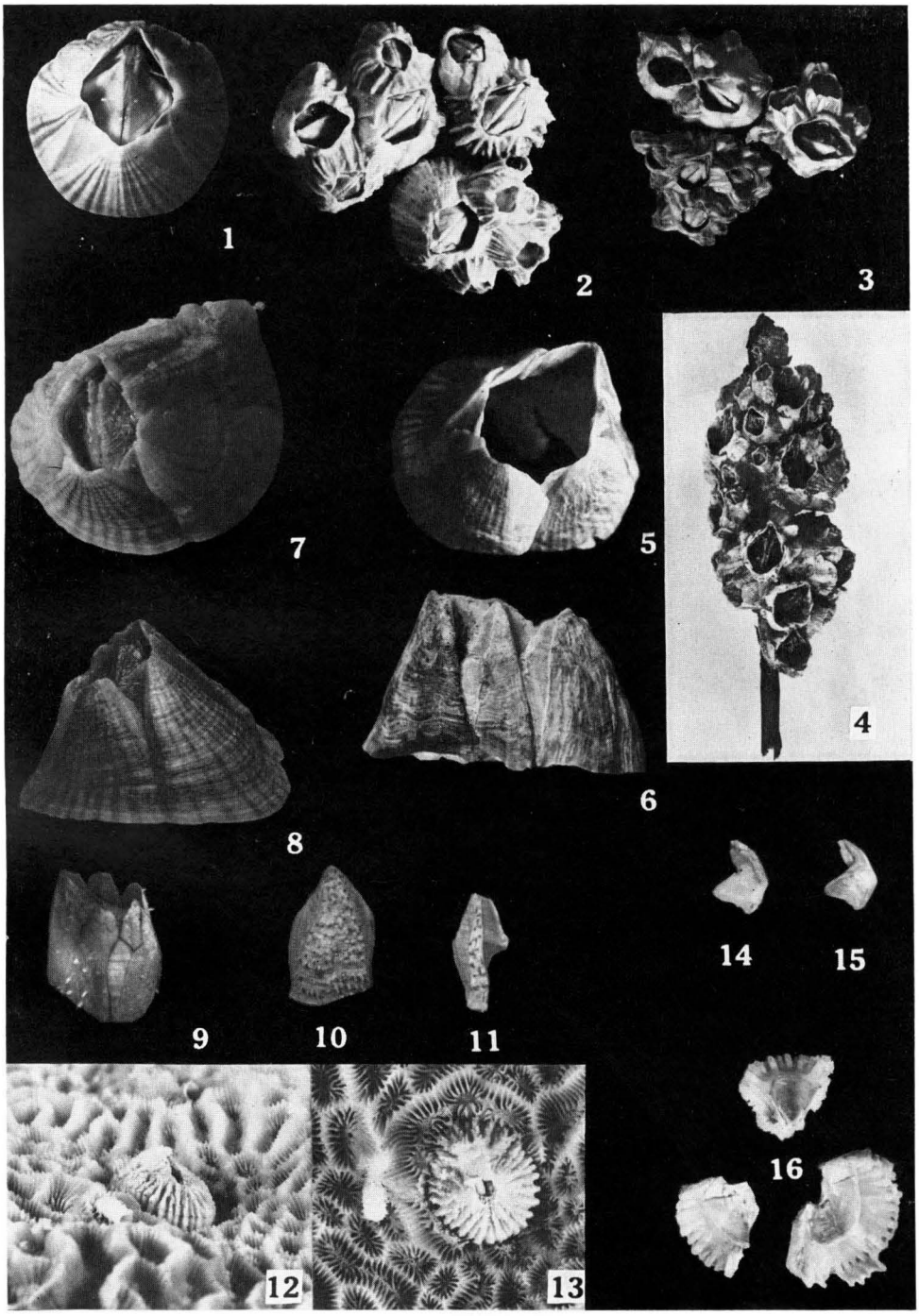
Fig. 12. *Creusia indica* (ANNANDALE) imbedded in the coral *Platygyra lamellina* (EHRENBERG) from Kusimoto, side view. ×1

Fig. 13. *Creusia indica* (ANNANDALE) imbedded in the coral *Platygyra lamellina* (EHRENBERG) from Kusimoto, side view. ×1

Fig. 14. Fused scutotergum of the same, inner view. ×1.3

Fig. 15. Fused scutotergum of the same, outer view. ×1.3

Fig. 16. Shell-plates of the same, broken into 3 pieces, inner view. ×1.3



H. UTINOMI: *Comments on Some New and Already Known Cirripeds*